JULY 28, 1958

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missiles and rockets

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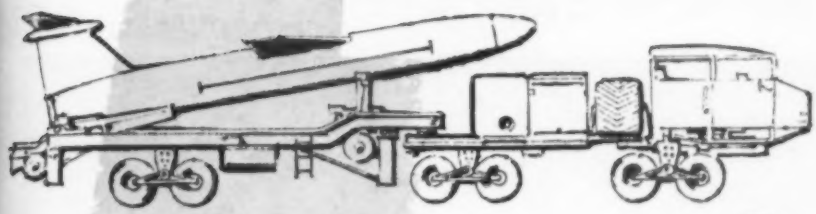
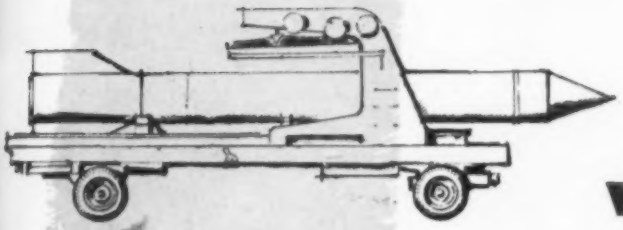
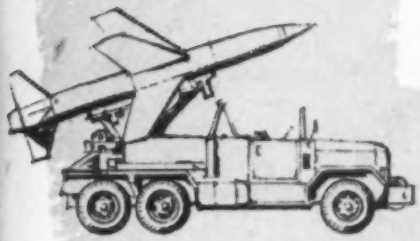
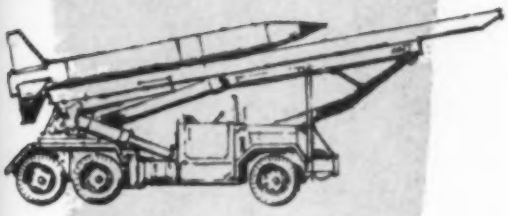
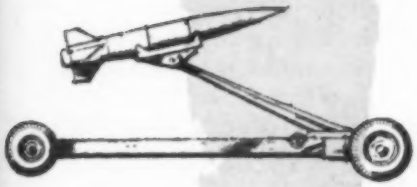


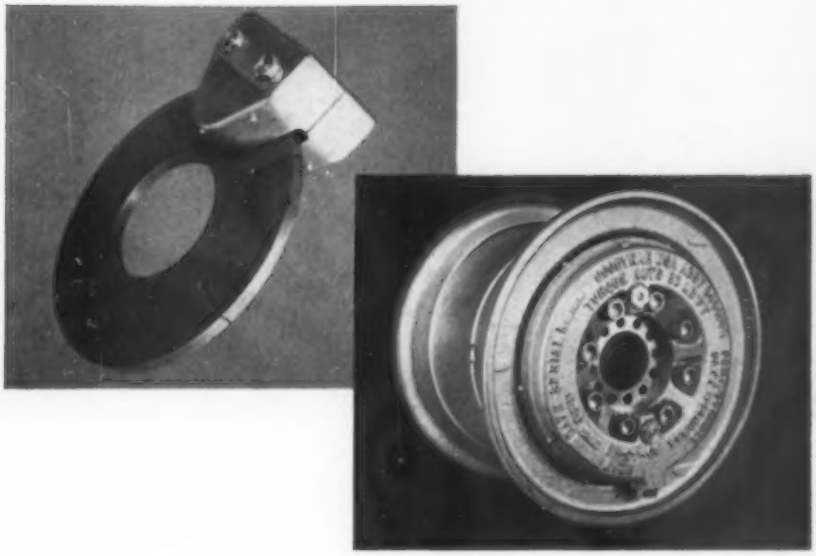








Got a brake or wheel problem?



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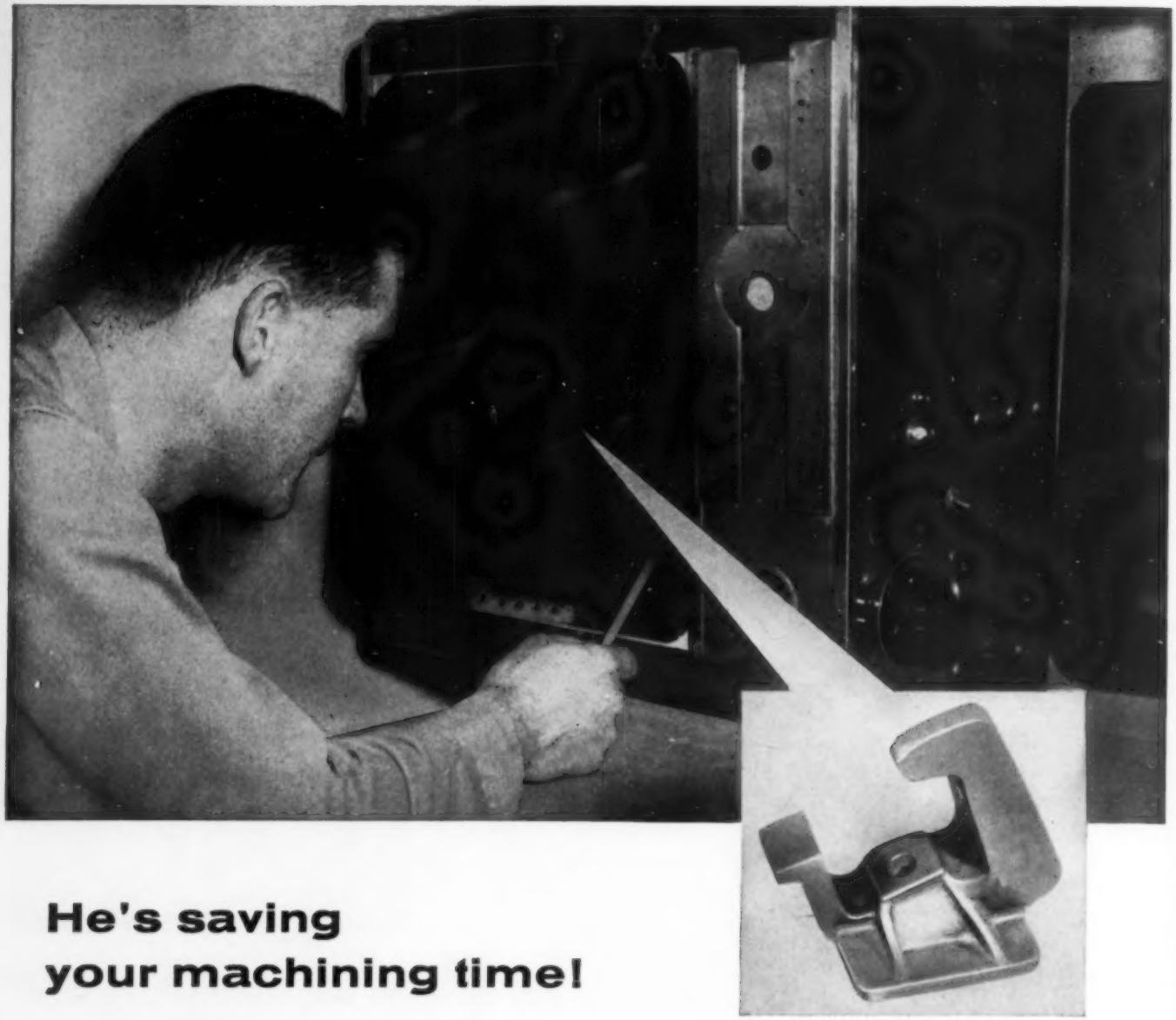

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the cover

The barking end of a bird that's ready for business—an operational Lacrosse missile on its field launcher getting a final check-out by troops before brief combat countdown. Lacrosse was designed by Cornell Laboratories, is manufactured by Martin-Orlando and is now in service with the U.S. Army. Though not fancy, it's a practical, high-precision pill-box getter that features greatly simplified, reliable operation in the field and is therefore a good example of engineering progress in missilery. One example of the operational simplicity of Lacrosse is the fact that its "go, no-go" box is no bigger than a "creepy-peepy" and can be carried back-strap by one man. Another feature is its wholly mobile, air-transportable launcher and trailer system. It proves: simplicity pays.

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Knowledge, Key To Space Progress

The extent of our penetration of space in the next few years, using instrumented and man-carrying craft, will depend in large measure upon how effectively we utilize knowledge already in hand, and upon how hard we work to reach the far-flung goals we have set. Except for the enormous progress made in the past 55 years toward solution of the problems of flight, we would be little closer to the exploration of space than the dreamers of early times.

Space flight requirements impose new and very difficult demands upon our technology. What is mainly required is raising to new, very high levels, our competence in propulsion, structures, and guidance and control. It may be over-simplification, but not over-statement, to say that what we must do to move into space compares to the technological advances which made possible the past transitions from wood-and-fabric to all-metal airplanes; from reciprocating to turbojet engines; from subsonic to supersonic speeds; and from low-level to high-altitude pressurized flight. Each of these remarkable gains in performance became possible because of the contributions of many men, working in many scientific and engineering disciplines.

For the future, we already see the need for new types of engines—nuclear-powered rockets, ion jets, and others. To develop these to a state of usefulness will require large effort, and years to accomplish. There is, however, no need for us to wait for the new engines. Our "conventional" rocket engine can be enlarged very substantially, and a rocket engine with a million pounds of thrust can be most quickly attained by use of a cluster of rockets, each producing several hundred thousand pounds. Nevertheless, development of the larger engine should be undertaken promptly.

Congress has already approved legislation creating a National Aeronautics and Space Administration, with prospects of early adoption. This move closely follows the recommendations of the President, upon the advice of able scientists led by Dr. James R. Killian Jr., for vigorous prosecution of our national space program by a civilian agency based on the NACA staff and facilities.

Since World War II the NACA has been engaged increasingly in research applicable to the problems of space flight, and at present nearly 50% of NACA's effort is applied in these areas.

To sum up, there are many problems common to aeronautics and astronautics, particularly those arising within the atmosphere on takeoff and during re-entry and recovery. There will be many other problems, some new and some old, such as guidance, communication, and new power sources.

No existing agency has within it all the skills and resources needed. There are no experienced astronautical engineers. Fortunately, there are scientists and engineers experienced in rocketry, aerodynamics, guidance, communications, structures, and human factors. These are the men who will have to solve our space flight problems.

Much of the activity of the NASA will be accomplished by a greatly expanded contract research program to obtain assistance from groups with special competence in specific areas. The course we will need to follow in moving into space is quite clear and straightforward. How fast and how far we go, in the last analysis, will depend upon the wishes of the 170 million citizens of the United States.

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the missile week

An m/r staff report from WASHINGTON

• **THE HOUSE COMMITTEE** on Appropriations has cut, by $90 million, the request for military construction funds for ballistic, defense and strategic missile systems. In its report, the committee said the cut was made to $182.5 million because architect-engineer work for certain portions of the *Titan* operational facilities has just been started and won't be completed until early next year. The lawmakers said more money could be requested when plans are firmer and cost factors more realistic.

• **ONE OF THE MORE IMPORTANT** aspects of the proposed Pentagon reorganization is the creation of a Director of Defense Research and Engineering. He should rank just below the secretaries of military departments, and would be authorized to "engage in basic and applied research regarding the development of new and improved weapons systems." He would be the chief adviser to the Secretary of Defense on research activities, and would be empowered to supervise and direct research, including the assignment of such activities to the various military departments.

• **NAVY CIRCLES** in the Pentagon are asking why North American's Scotty Crossfield will pilot the X-15 only on the low-speed and low-level tests. USAF's Captain Iven Kincheloe is scheduled to take the $100 million craft over the real jumps—a definite departure from the normal practice of having the manufacturer complete full-scale tests prior to delivery.

• **INITIAL FLIGHTS OF THE X-15** probably will utilize a dual system of engines used in its predecessors. However, the Reaction Motors power plant should be available within months after first flights. First low level flights are expected early in 1959. Full scale flights probably will not be made until 1960. *Atlas* and several other missiles are being mentioned as the booster to put the X-15 into orbit.

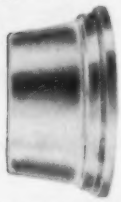
• **AS M/R WENT TO PRESS** the Army was preparing the *Explorer IV* vehicle for launching. Primary reason for the delay has been the lack of proper instrumentation for the satellite. This instrumentation is designed to measure the belt of heavy radiation detected by previous satellites.

• **A LARGE PART OF THE $50 MILLION** which ARPA has available may go into additional launching facilities at Cape Canaveral and Cooke AFB. ARPA demands the healthy respect from all Pentagonites, but frequently the tune ARPA plays strikes a discordant note to those who must comply. Take *Pied Piper:* one military observer comments, "They took a big chunk of the money we fought so hard to get, they took one of our shops to do the work, and now won't even let our shop people talk to us."

• **LOST IN THE GLARE OF HEADLINES** on the Middle East situation was the Army's second successful recovery of a full-scale *Jupiter* IRBM nose cone. The fact that the *Jupiter* for a second time has been fired successfully, inpacted in designated area, and has been recovered removes any doubt that it is on the threshold of full operational status. Reports in Washington are that during this second firing, the arming and fusing device underwent its first tests in flight, and with success." For this, and other reasons, don't be surprised if *Jupiters* are deployed to overseas IRBM bases before *Thor*.

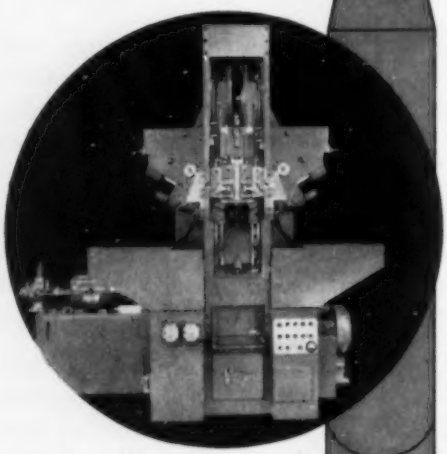
• **AT WEEK'S END** a major topic in capital missile circles was the outstanding progress of Aerojet-General, as the Air Force announced award of contracts to Aerojet involving the second and third stages of the top AF project—*Minuteman*. Reflecting this expansion was another announcement from the company itself: election of five new vice presidents. Those receiving the nod from Chairman Dan Kimball and his board of directors and their areas of responsibility were: Bernhardt L. Dorman—Test Engineering; Richard D. Geckler—Solid Rocket Plant, Sacramento; William L. Gore—Customer Relations; William L. Rogers—Azusa Operations; John S. Warfel—Avionics.

Explorer Nose Cone
Approx. 6″ x 12″



Starter Bearing Mount
Approx. 4″ x 9″

Nike Venturi Nozzle
Approx. 14″ x 33″



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Industry countdown

Money

ARPA has revised its FY 1959 program estimates with new totals as follows (in millions): military space technology $173.6 (up from $138.2); solid propellant research, $20; communications, $9; navigation, $1; cloud cover reconnaissance, $6; component development, $10; launching vehicles, $42; exploratory research, $12.6; maximizing payload capability, $5.7; man in space, $50; satellite tracking, $17.3; total ARPA estimate: $520 million . . . **Navy's asked for $158 million** for aviation facilities construction, including $52.5 million to support fleet ballistic missile program and $18.1 million for Pacific Missile Range at Point Mugu.

Missiles

First full Convair Atlas to be launched from Cape Canaveral was destroyed due to wild gyrations just after take-off . . . **Full Martin Titan** is on test stand at Denver for static firing . . . **North American** X-15 manned rocket space-flight research plane will be equipped initially with engines similar to those in X-1; will get its full power plant later; all are made by Reaction Motors Div. of Thiokol.

Mergers

Houdaille Industries, Inc., Buffalo is purchasing Provincial Engineering Ltd., Niagara Falls, Ont., for cash . . . **National Tool Co.,** Cleveland, has acquired assets and assumed liabilities of Auto-Vac Co., Bridgeport, as part of long-range diversification . . . **A new company,** CFI (Ceramics for Industry) Corp. has been organized in a 15,000-square-foot plant at Mineola, N.Y. . . . **The Cosmodyne Corp.** in Los Angeles has been formed to R&D secondary power sources for missiles, satellites and manned space vehicles; address 2639 So. Laccienega Blvd., L.A. 34.

Expansions

NAA subsidiary, Navan Products, Inc., is moving general offices from Santa Monica to 900 N. Sepulveda Blvd., L.A. 45. . . . **Minnesota Mining & Manufacturing Co.** has formed a Missile Industry Liaison staff with offices at 900 Bush Ave., St. Paul . . . **Douglas Aircraft Co.** has formed Nihon Douglas Hikoki K.K. at 9 Roppongi, Azabu, Minato Ward, Tokyo for sales promotion and service . . . **175 Lockheed Missile Systems div. Polaris** engineers have moved into Sunnyvale Naval Industrial Support facility, with more to follow . . . **Bendix Aviation Corp.** has changed name of its controls section to

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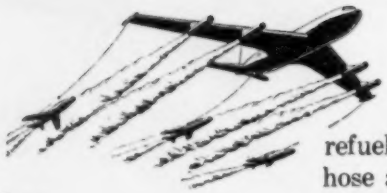
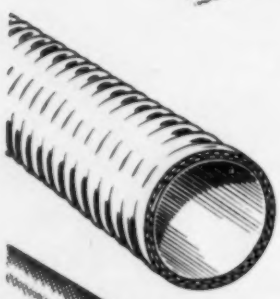


IN-FLIGHT REFUELING HOSE? Vital feature of the probe and drogue method of refueling is the compact, easy-to-handle hose and integral coupling assembly developed and manufactured by Hewitt-Robins. Aerodynamically balanced hose trails at high speed without wobbling, absorbs tremendous shock loads, and provides maximum safety.



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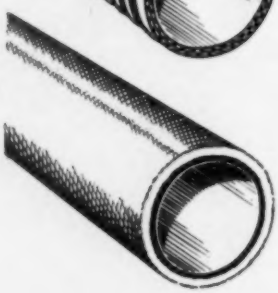

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...industry countdown

Industrial Controls Section . . . **Raytheon Mfg. Corp.** has set up Government Relations branch office at Santa Barbara . . . **Pennsalt Chemicals Corp.** is moving its regional office from Pittsburgh to Natrona, Pa. August 4 . . . **Flexonics, Corp.,** Maywood, Ill., has formed four regional sales offices at Maywood; Inkster, Mich.; Elizabeth, N.J.; Santa Ana, Calif. . . . **International Telephone and Telegraph Corp.** has established an Astrionics lab. at Ft. Wayne, Ind.

Ryan Aeronautical Co., San Diego, has bought 11 more acres at Torrance, Calif., as part of its current expansion . . . **Hoffman Electronics Corp.** Semiconductor div. has acquired 40,000 square-foot neighboring plant in Evanston, Ill. . . . **Packard-Bell Electronics Corp.** has added 20,000 sq. ft. of leased space to its Technical Products div. in West L.A. . . . **Canadair Ltd.,** Montreal, has begun construction of a $1 million environmental lab for missile work . . . **Bruce Industries,** Gardena, Calif. has organized ATOHM Electronics div. . . . **Technitrol Engineering Co.,** Philadelphia electronics firm, has opened an office at 252 N. Irving Blvd., L.A. . . . **Genesys Corp.,** Chance-Vought subsidiary says it's now in business of industrial process control . . . **Owatonna Tool Co.,** Owatonna, Minn., has opened a new warehouse in Chicago.

Technology

Convair Inter-Division Research and Development Center is building a $500,000 gas-driven hypersonic gun to simulate velocities of 13,500 mph . . . **GE Missiles & Ordnance Systems div.** says it is operating country's largest plasma jet for reentry study . . . **Reports are in circulation** of a major break-through possible in manufacture and handling of storable liquid fluorine/hydrogen combinations . . . **National Research Corp.** reports commercial production of very high purity tantalum metal with production capacity at 30,000 pounds a year and expanding.

Finance

Douglas Aircraft Co. reports $593,974,000 sales and $12,645,000 net earnings for six months ending May 31, compared to $565,580,000 and $16,674,000 respectively for comparable period last year . . . **Fairchild Engine and Airplane Corp.** reported to stockholders that company has lost $5 million after taxes for first half of 1958 . . . **Boeing Airplane Co.** has de-

clared regular third quarter dividend of 25¢ a share payable September 10 to stockholders of record August 20 . . . **Boeing** is offering two bond issues totalling $70 million—$40 million at 5% and balance at 4½% . . . **North American Aviation, Inc.,** reports a $18.2 million net income after provisions for $19.7 million for federal taxes and earnings of $2.27 a share for nine months ended June 30, compared to $26.6 million and $3.32 a share for same period last year; sales were $678.9 million and $937.1 million respectively . . . **Douglas** declared a 3% stock dividend payable August 29 to stockholders of record on July 30 . . . **IBM Corp.** reports a net income of $50.6 million for six months ended June 30 compared to $40 million for comparable period in 1957, with earnings of $4.27 and $3.38 a share respectively . . . **Thompson Products, Inc.,** and subsidiaries reports sales of $141.6 million for first six months of 1958 compared to $196 million for same period of 1957 . . . **ACF Industries, Inc.,** reports net sales of $294.9 million for fiscal year ending April 30 compared to $294.6 million last year.

ARPA Briefs

Director Roy W. Johnson of Advanced Research Projects Agency has named William Hutchins, formerly with Raytheon's Missile System Division, to head a Ballistic Missile Defense Group for R&D.

Serving with Hutchins will be Dr. Wade Blocker, kill mechanisms; Clifford Cummings, interception; Stuart Hight, data processing for decisions; Dr. Richard Holbrook, active defense; Harry Iddings, radar; Dr. Ward Low, upper atmosphere physics; Dr. David Luck, very early warning; Dr. Glenn Pippert, range instrumentation and special ranges; Dr. Leroy Tillotson, anti-satellite.

One top AF spokesman said that *Minuteman* could be designed to serve as a multi-purpose weapon. As a single stage vehicle, it would be a tactical weapon with a 200-400 mile range. A two-stage concept would have IRBM capabilities; and with three stages, an ICBM capability.

Already many Washington officials talk about ARPA as becoming the cornerstone for a U.S. Space Force and unofficial thinking is that its current, approximate budget of 500 million dollars will be more than double for next fiscal year. "Beauty of ARPA," one Pentagoner says, "is that it is the stepping-stone to a unified service for space flight—which is just what this country needs. And industry will benefit . . ."

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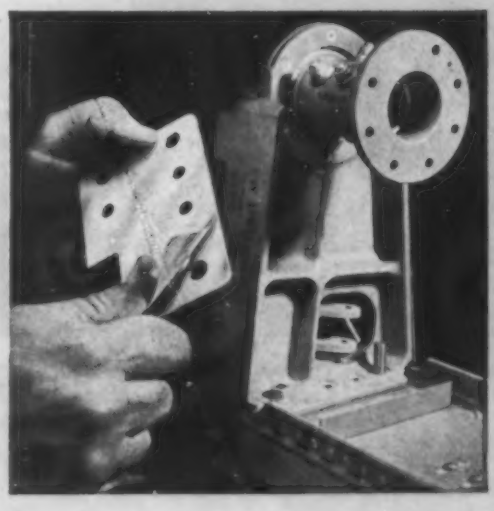

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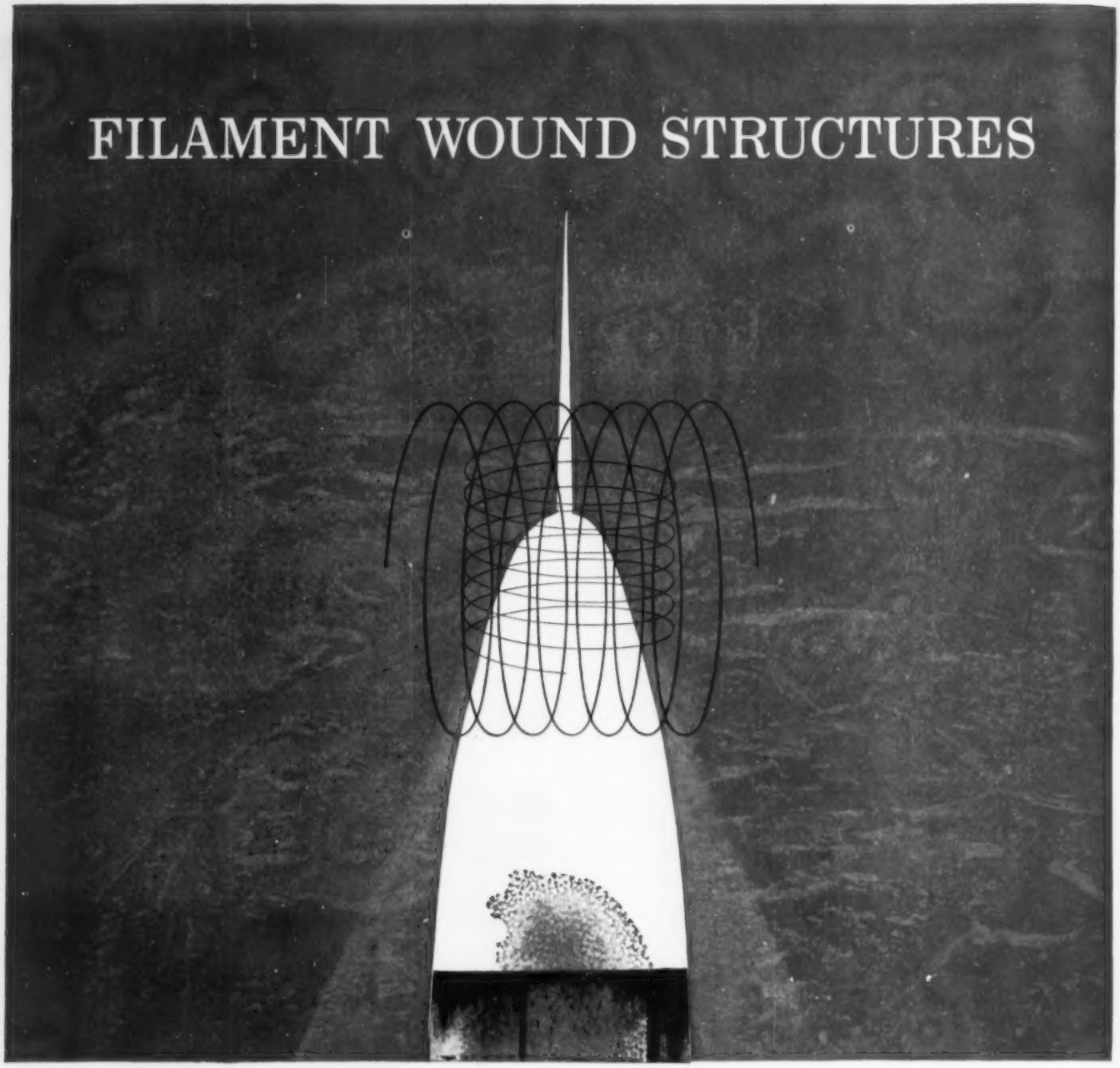

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JULY 28, 1958
VOL. 4, NO. 4

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

AICBM Defense Cost: $2 Billion Yearly?

Money Will Go to Build New Protective "Fence" Against Missiles; Operational *Nike-Zeus* Seen in Four Years

by Donald E. Perry

COLORADO SPRINGS—North American Air Defense (NORAD) is stepping up its missile defense capability against the manned airplane and the air-breathing missile, but will have to wait four years for an operational anti-intercontinental ballistic missile.

This program, however, will mean billions more dollars annually for aircraft and missile systems extending from the southern border of the U.S. north to Canada, Alaska and U.S. bases in Greenland, under NORAD's 200,000-plus personnel operation.

NORAD leaders are faced with a cold fact: Even though some $18 billion has been spent in the past nine years for modern radar, detection and interception against aircraft, the entire system is not nearly adequate to cope with any missile threat from abroad. But it still must be supported and maintained for another 10 years, until missiles have supplanted the airplane as an enemy's striking force.

In a recent tour of NORAD's nerve system, three members of Congress said they were "shocked" by a statement that NORAD's AICBM capability alone would require $2 billion annually "from now on." This sum is in addition to the $8-10 billion which is now being spent each year—and will continue until 1965—as defense against the manned bomber threat alone.

In an interview with m/r, top NORAD leaders brought out these facts:

- It will take two years before the U.S. Air Force has radars available for the Ballistic Missile Early Warning System (BMEWS), and another two years before operational *Nike-Zeus* are available.
- BMEWS and *Zeus* missile in AICBM program will cost $2 billion annually for "many years to come."
- Canada will soon introduce the U.S. *Bomarc* IM-99 pilotless interceptor for defense of Canada. According to Air Marshal C. Roy Slemon, RCAF, Deputy Commander-in-Chief of NORAD, "Canada critically needs and wants a long-range interceptor missile." He said exact plans on integration of the *Bomarc* in Canada, which now has no surface-to-air missile capability, have not been set by the Canadian government, but *Bomarc* may be produced in Canada under a licensing agreement. Whether U.S. or Canadian troops will man the *Bomarc* sites is undecided.
- Canada is not considering *Nike-Ajax* or *Nike-Hercules* in its system.
- Canadair, through RCA, will hold prime manufacturing responsibility for the U.S.-developed *Sparrow II* air-to-air missile, now being flight tested on Canadian CF-100 interceptor aircraft.

At this time, no plans have been formulated for Canada to have BMEWS radar stations. Most will be located in Alaska. Canada, however, will be "extensively involved" in the BMEWS communications and data assimilation networks with a good many stations programmed for construction on Canadian soil.

Another hard task ahead for NORAD: new selling efforts to the American and Canadian public and a renewal of the 1946 cycle with more emphasis on NORAD's role as a deterrent force with Strategic Air Command.

Why is this necessary? Air Marshal Slemon estimates that 25% of Russia's defense effort is going into air defense, and NORAD's effort "is considerably lower." Russia, he feels, simply started preparing for air defense earlier than Canada or the U.S. "It should be crystal clear why we must catch up and remain ahead," he said.

AF Revises Contract Procedure

By William O. Miller

In an effort to reduce the development-production time of advanced weapon systems, the Air Force is revising obsolete procedures for weapon system completions.

In an interview with m/r, Lt. Gen. C. S. Irvine, Air Force Deputy Chief of Staff, Materiel, said under the new policy, qualified contractors will be screened on their capability, past experience, design approach, and management techniques.

This means that one, two, or more contractors will be given a contract to proceed with Phase I design, which will include such projects as wind tunnel work and mock-ups. The Air Force will evaluate these contract efforts until one contractor can be selected.

These techniques were used in choosing North American Aviation, Inc. the contractor on the B-70 and F-108.

General Irvine pointed out that as the complexity of modern weapon systems continues to increase, it becomes more incumbent on the Air Force to assure that the maximum effort and results are obtained for each dollar spent. This has created trends in the practices and policies of contracting where a maximum amount of incentive for efficiency is created.

Lt. Gen. C. S. Irvine

- **Need better data**—"Time was," Gen. Irvine said, "when, if we had a decent estimate of the weight of a system, our knowledge of cost per pound would allow us to come up with good cost data. With the fantastic jumps in

performance and its direct companion complexity that are now being made from one system to the next, historical data becomes less and less useful.

"Some of the complicating factors are the problems of new and untried materials and processes, tolerances that the 'state-of-the-art' could not visualize too long ago, and the need for unmanned vehicles to be in a state of readiness for years before they may need to be fired.

"In weapon system contracting, we usually start out during the study, and strictly development stage, with a contract that allows for a fixed fee. As early as possible, however, we switch over to an incentive contract to create maximum initiative and get the most for our money—the goal that I described previously.

"This is not a firm formula and each case, of course, merits and gets special consideration. For example, on the KC-135 we were able to start out initially with an incentive contract and a good firm target price. This was possible because of cost data available from an earlier company effort on a similar commercial version of the airplane and from information available from design competitions.

"The incentive approach," Gen. Irvine continued, "is nothing more than dealing with our contractors on the basis that, if they do a better job, they earn more profit. The degree of split between the Air Force and the contractor on money saved varies in the incentive formula. The application of the proper formula is determined by many things; one of the most important is risk."

• **Picking contractors**—Contractor selection is much more difficult than it formerly was, according to Gen. Irvine. The policy used to be to canvass the entire industry and request detail proposals to meet the stated requirements. The Air Force would review and evaluate these proposals and award a contract to one company for detailed design and fabrication of flight test systems.

"The disadvantages of such a method are obvious," Gen. Irvine said. "The Air Force (depending on the number of contractors involved) could spend as much as a year doing the evaluation. Time is a luxury we cannot afford.

"The Air Force is doing everything possible to promote fair and honest competition, while at the same time we are making every effort to reduce the development-production time cycle. We are also using all the tools at our command to establish a maximum initiative and incentive in our contracting procedures. These efforts have paid and will continue to pay dividends."

Minuteman-AF Contract Switch

by Norman L. Baker

An example of the Air Force's swift change in business procedures (p. 49) is its approach to the weapon system concept in the *Minuteman* program.

For the first time, there will not be an industry prime contractor. Instead, m/r has learned, the prime manager will be the Ballistic Missile Division with Ramo-Wooldridge acting as technical assistance manager.

Five contractors were selected for research and development efforts on the three-stage ICBM. This was the culmination of about a year of investigation of the problems involved capabilities of several companies.

The contractor selection will be followed by contract awards as soon as the Department of Defense releases the funds to the Air Force and the paper work completed. The amount of the contracts was not announced pending the formal contract releases.

At least five companies were in the running for the development of the large solid propellant grains required for the land-based missile. Thiokol Chemical Corp. received the contract for the first stage, with limited backup by Aero-General. The first stage grain is reported to be 6 feet, 5 inches in diameter. Development and production of the propellant for this stage is expected to be at the Thiokol-Utah division.

Aerojet-General will develop second and third stages, with a backup program by Thiokol. A radically different motor case will be used in the Thiokol second stage. In addition to the Thiokol backup on the third stage, there will be a limited research program by Hercules Powder Co. (ABL) for investigation of the double-based propellants. Second and third stages are reported to be 44 and 37 inches, respectively.

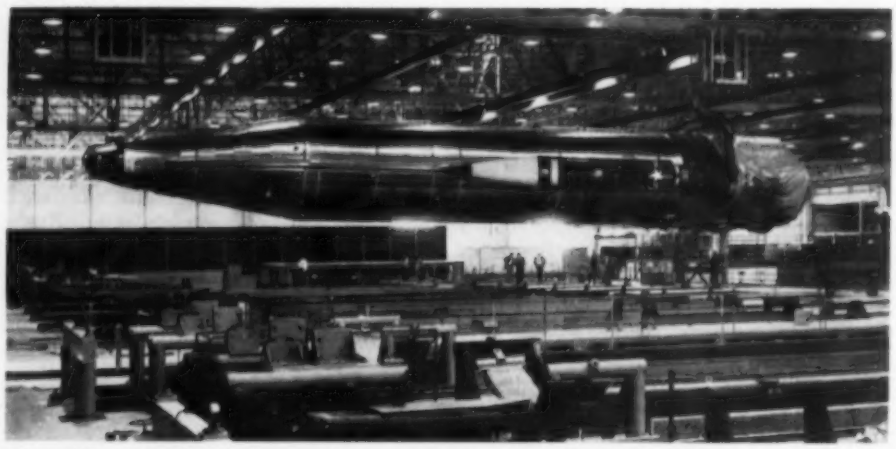
Astrodyne and Grand Central Rocket Co. were top contenders for the upper stages. These companies are expected to be called in on a follow-on program.

The Autonetics Division of North American Aviation will develop the guidance system, expected to be pure inertial. Autonetics was recently selected as a subcontractor on the *Dyna-Soar* boost glide bomber team headed by Boeing. Avco Manufacturing Co. has been assigned the development of the nose cone for the solid propellant bird. Avco is curently engaged in the development of nose cones for the *Titan* ICBM and the Navy's *Polaris* Fleet Ballistic Missile.

Jupiter Nose Recovery Affirms IRBM Status

The recovery by the Army of a second full-scale *Jupiter* IRBM nose cone on July 17 removes any doubt that the missile is on the threshold of full operational status.

The successful recovery of the nose cone affirms that the *Jupiter* team has solved the warhead protection problem. The cone recovery gear, developed by Cook Electric Company, Evanston, Ill., consisted of a large colored balloon, signal lights, radio transmitter, and other instruments which aided in the location of the cone.



AN *ATLAS* MISSILE is moved by overhead crane across the high-bay area in the new assembly plant by Convair Astronautics. Manufacture of the *Atlas* is now underway at the plant. The Air Force made five attempts to fire the first full-powered *Atlas* last week without success. The missile, destroyed after 45 seconds because of erratic flight, was equipped with three engines developing a total thrust of 360,000 pounds (boosters—300,000 at 150,000; sustainer—60,000).

Thiokol Disclaims Plan to be Prime Contractor

Thiokol Chemical Co. has no plans to become a prime systems contractor, according to Dr. H. W. Ritchey, Vice President.

Dr. Ritchey stated that "The history of engine development and production activities in this country had demonstrated the validity of separating such activities from airframe development and production.

"We believe," he continued, "that the current tendency to combine a wide range of technologies into a single organization can only serve to weaken the technological strength of many of the groups engaged in sub-system development. The current tendency to integrate rocket development technology with prime systems capability could have a very debilitating effect upon the whole industry."

In its own field of rocket engines, Thiokol has enjoyed a constantly expanding role. Besides the recently-announced first-stage engine for *Minuteman,* Thiokol also produces engines for *Sergeant, Falcon, Lacrosse;* the booster for *Matador-Mace;* and has participated in the *Hawk* and *Polaris* programs.

During the past year, Thiokol made the following aquisitions aimed at complete rocket engine capability: Reaction Motors, liquid rocket motor specialists; Hunter-Bristol, metals firm; and National Electronics.

House Forms Permanent 25-Man Space Committee

A permanent committee on science and astronautics to handle all space legislation has been established by the House.

The committee will consist of 15 members and will have jurisdiction over all legislation relating to basic scientific research, science scholarships, the Bureau of Standards and the National Science Foundation.

House Democratic leader John W. McCormack called the committee one of the most important in Congress. The committee was established by voice vote of the House, under sponsorship of Democratic Whip Carl Albert.

A Select House Space Committee, which previously handled space legislation, will pass out of existence at the end of the present session of Congress.

British IRBM Bases Set; France Delays *Jupiters*

While plans are moving ahead for the activation of the first of the four *Thor* missile bases in Britain—probably before December—the hoped-for deployment of *Jupiter's* to France is temporarily on the shelf. The French government of Gen. De Gaulle insists on attending to what it considers more pressing problems.

The original target date for sending the IRBM's to France had been set for March of next year. The delay will force a postponement. Three bases have been mentioned as the initial number for France.

Present production of *Thor* is considered ample for current commitments and test requirements. Douglas engineers and test personnel are presently carrying out the final phases of delivery of *Thor's* at the bases. The British will man only partially the bases in the beginning, but eventually will provide all personnel. Meanwhile, Britain is furnishing sites, local construction and other housekeeping requirements. The warheads will remain in the custody of the U.S.

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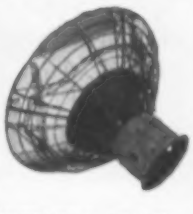

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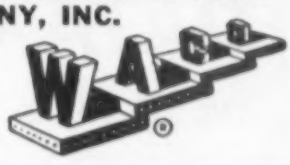

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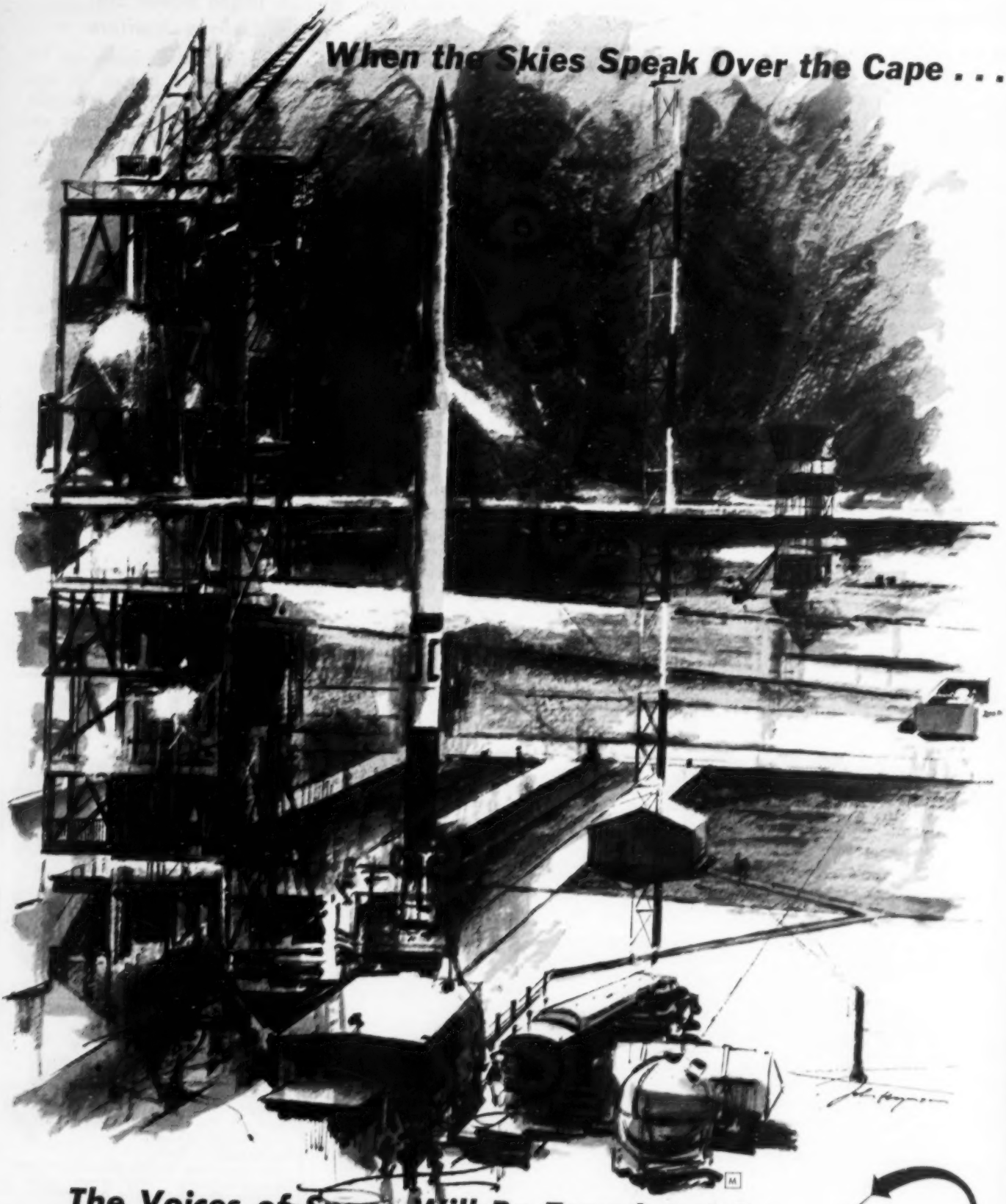

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Progress Report:

AFBMD: Catching Up With the Soviets

by Maj. Gen. Bernard A. Schriever, USAF*

NEXT MONTH, THE AIR FORCE Ballistic Missile Division will mark its fourth anniversary. These past four years have been busy, eventful ones.

AFBMD's initial task was to develop a ballistic missile capable of carrying a thermonuclear warhead to intercontinental ranges—namely, the *Atlas*. Today we are in the advanced development phase of three liquid propellant ballistic weapon systems—the *Atlas* and *Titan* ICBMs, and the *Thor* IRBM.

We have recently entered the initial research and development phase of the *Minuteman*, an ICBM using solid propellants with advanced components and configuration.

In addition, AFBMD manages the research and development aspects of a proposed satellite for observation purposes and scientific study. More recently, AFBMD was assigned the task of developing and operating an unmanned outer space vehicle capable of making a close approach to the moon for the purpose of basic scientific research. The latter two projects are under the direction of the Advanced Research Projects Agency of the Department of Defense.

• **Quick and complete** — When AFBMD was assigned its task four years ago, it was faced with the necessity of cutting the time normally required to build and operate in the field a weapon system of comparable size, complexity and novelty. It was realized at the outset that an entirely new approach to the problems of weapon system development-management was called for.

Therefore, the decision was made four years ago to undertake all phases of the design-to-production-to-operation cycle concurrently, rather than sequentially. This approach involved carefully-calculated and balanced ingredients of talent and resources. Today that combination is paying off handsomely at Cape Canaveral, where *Thor* and *Atlas* are progressing beyond expectations in the flight test phase. *Titan* is expected to follow sometime this year.

The concurrent approach to weapon system development required designing the operational bases and the

ground support equipment systems before the operational missile designs were off the drawing boards. Training plans and logistic support plans were drafted along with the test plans.

Construction of Cooke AFB, the combination training and operational launching base, was started before the first ICBM test missile was launched. Other purely operational bases will be ready for use before the completion of the test program.

A complete prototype of the *Thor* launch emplacement was assembled, checked out and operated by crews of the Strategic Air Command several months ago. Equipment of this type is already being shipped to operational destinations ahead of original deadlines, which were considered optimistic several years ago.

It is this concept of concurrent action that will make it possible to attain an operational capability for *Thor* before the end of this year—only three years after the signing of contracts.

• **For the future**—By dealing boldly and realistically with the needs of the present, we have, at the same time, equipped ourselves to contribute to the needs of the future. In the process of developing the first generation ballistic missiles, we have made a capital investment in space technology of over $500-million worth of new facilities, which form the previously nonexistent building blocks for the development, testing and production of ballistic missiles and space vehicles.

We have also gained invaluable experience in the planning and management of multi-billion dollar projects of unprecedented complexity and compression. The three original ballistic missile programs alone involve 18 major contractors, more than 200 principal subcontractors, and over 200,000 suppliers and vendors.

The most noteworthy—and certainly the most noticeable—aspect of the ballistic missile program during the past year has been the flight testing at Cape Canaveral. For those of us who are directly engaged in the ballistic missile program, the tests are the first gratifying returns from calculated risks that had been assumed years earlier.

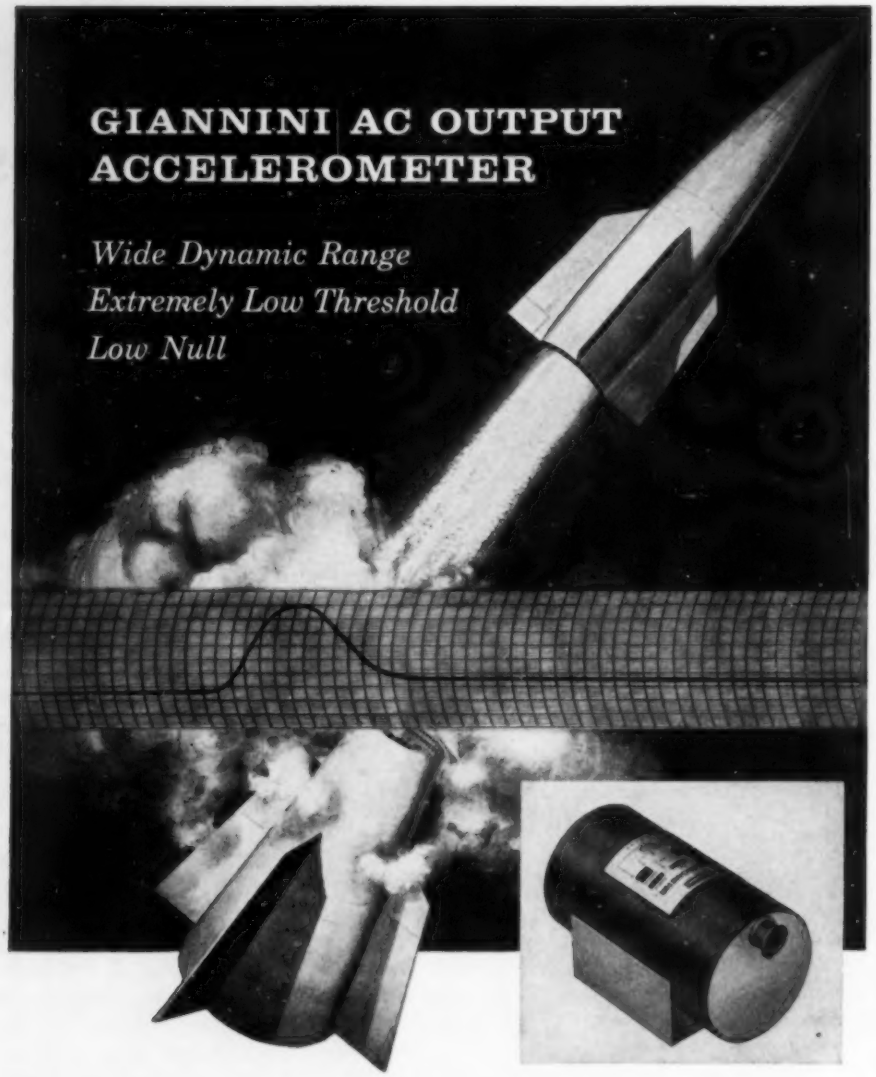
From here on, we see the development of *Thor* and *Atlas* as straightforward engineering tasks, with no unsolved scientific mysteries or dead-end testing. How can we have such confidence before the successful completion of an extensive flight test program? The answer lies in the fact that flight testing is the culmination, rather than the commencement, of the test phase of an Air Force ballistic missile.

For a point of reference, consider that the Germans in World War II flight tested some 2000 V-2's before they considered that the weapon was ready for operational use. It is obvious that with complex and expensive missiles such as the *Atlas*, *Titan* and *Thor*, we cannot afford the time, money or other resources to conduct such a numerically large flight test program.

It is not necessary to conduct such a program, even though a single flight yields only a few minutes or even seconds of precious data. This data accurately and faithfully records the pulse of the missile throughout its life span. The problem we face—to minimize the number of flight tests and maximize the effectiveness and usefulness of the flights that are made.

• **Program**—AFBMD's test program is, therefore, based on these

**Commander, ARDC Ballistic Missile Program.*



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fundamental principles:

1) "Dead-end" testing is avoided wherever possible.
2) All testing is done at the lowest possible level.
3) Flight test results are utilized to the maximum.

The decision to avoid "dead-end" testing wherever possible means that instead of developing special test vehicles, the missiles themselves serve as data-collectors. The missiles being flown today are made up of the same components and subsystems that will be used in the operational missiles.

These components are fabricated on production lines, using production drawings and tooling. By this means, we are constantly broadening our statistical experience on the operational hardware and improving our manufacturing methods and procedures.

To aid in understanding the principle of testing at the lowest possible level, we can represent the overall test program as a pyramid. The broad base of the pyramid is the component testing, in which each part, component, and subassembly is individually tested in excess of anticipated flight conditions.

Having proven the design, we next assemble the components into subsystems and again test exhaustively, but now with the added factor of component interactions. Moving higher up the pyramid, we reach complete system testing, but under "captive" conditions on the ground. Here we are able to assess the interactions of the several subsystems during a "hot" firing sequence.

Of course, some of the environmental conditions of flight can never be fully simulated on the ground, and we must finally commit missiles to free flight—but not before all probable causes of malfunction have been sought out and removed at the lower levels of testing. By this program of careful and progressive testing, we gain maximum assurance that the free missiles will perform as planned.

It should be recognized that a highly sophisticated long range ballistic missile such as *Thor, Atlas* or *Titan* cannot be expected to function perfectly each time it is flight tested, particularly in the early stages of a program. If we knew in advance that every subsystem would function perfectly in flight, it is obvious that we wouldn't need a flight test program.

Even a so-called "failure" provides invaluable experience in the difficult tasks of checking out, fueling and preparing a missile for flight. A flight of

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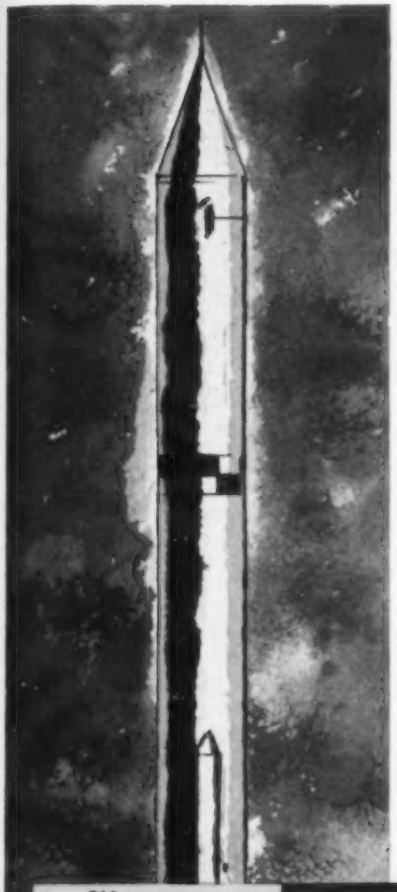

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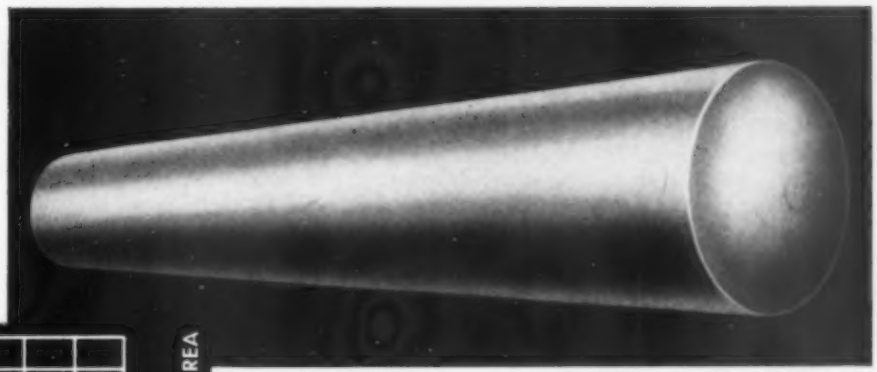
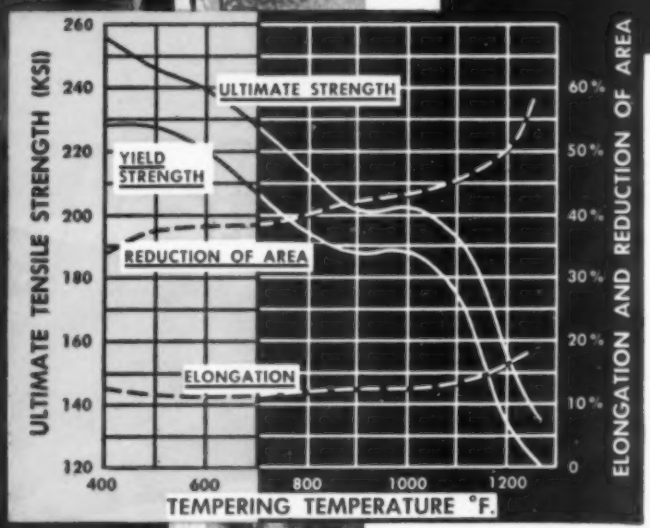


Typical missile propellant tank as produced by A. O. Smith. Diameter is 40", length 28'. The highly stressed longitudinal welds in the "roll and weld" fabrication method can be flash-welded for higher strengths.



Materials are available which will produce properties indicated above. Current lightweight, high-strength propellant tanks are being produced in the strength range indicated by the yellow area of the chart.

Here's a new opportunity to gain wider design latitude. A. O. Smith can fabricate liquid or solid propellant tanks (cylindrical or spherical) and pressure tanks to practically any chamber size.

A. O. Smith has produced tanks with guaranteed minimum yield strengths of 190,000 psi. . . . wall thicknesses from .050"-.220" . . . diameters over 50" . . lengths to 28'. Proposed designs and recent fusion weld developments indicate minimum yield strengths of 210,000-225,000 psi are attainable in weld areas.

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less than the planned duration will furnish precious data on vibration, fuel sloshing, engine ignition and burning, critical temperatures, and component interactions.

• **Objectives**—When we finally reach the flight test phase, our objective is to obtain the greatest possible amount of the most usable kind of data. Each flight is assigned specific test objectives, which vary in progressive steps from missile to missile.

Initially, our interest centers on the brief period of powered flight. Later, missile behavior throughout the entire trajectory of a full distance flight is scrutinized. A typical test might yield over 100 different telemeter measurements, along with the highspeed photographs obtained during the visual portion of the flight.

The test objectives of a given flight frequently include the acquisition of data needed for more than one of our three ballistic missiles. For example, *Thor* flights have carried, as part of their instrumentation, equipment that will be used in the *Titan* guidance system. This advantage derives from AFBMD's centralized management of the entire Air Force ballistic missile program.

The test data obtained from all flights, whether wholly or partially successful, is processed at data reduction centers and analyzed in meticulous detail. When a failure has occurred, its causes are sought and theoretical solutions proposed. The resultant "fixes" are then verified in a new pyramid of ground tests before committed to flight test. Test data obtained is also made available to both the Army and Navy for their use.

Before considering AFBMD's newer projects, a word is in order regarding the decision-making process by which advanced projects are conceived.

It is well to note here that a scientific breakthrough in a single area of technology does not in itself constitute the basis for a new generation of weapons. All of the major subsystems must be brought along together to a new level of sophistication that will justify the commitment of time and resoures to the new project.

Thus *Minuteman*, for example, will not only be the beneficiary of a major breakthrough in solid propellant technology, but will also incorporate projected advances in airframe, guidance, and warhead technologies. In addition, developments in related scientific aspects such as geodesy and gravimetry, are being projected ahead to the target date for the operational *Minuteman* and made part of the design criteria.

Similarly, more rigorous strategic requirements, such as those related to the ability to withstand attack, are "cranked in" to the new weapon system design and operational environment. Operational requirements such as reaction time, reliability and vulnerability are made more stringent.

• **Long range logistics**—These subsystems and environment improvements are projected on a time scale so that they will intersect at the target date, several years distant, for the operational use of the new weapon system.

This type of planning is necessary to assure that major subsystems will be mutually compatible, and that the new weapon system will incorporate the most advanced technology that can be anticipated. Of course, plenty of latitude is allowed for unforseeable refinements that will be made in the state of art as the research, development, operational effort and experience progresses.

For example, *Thor* subsystems are

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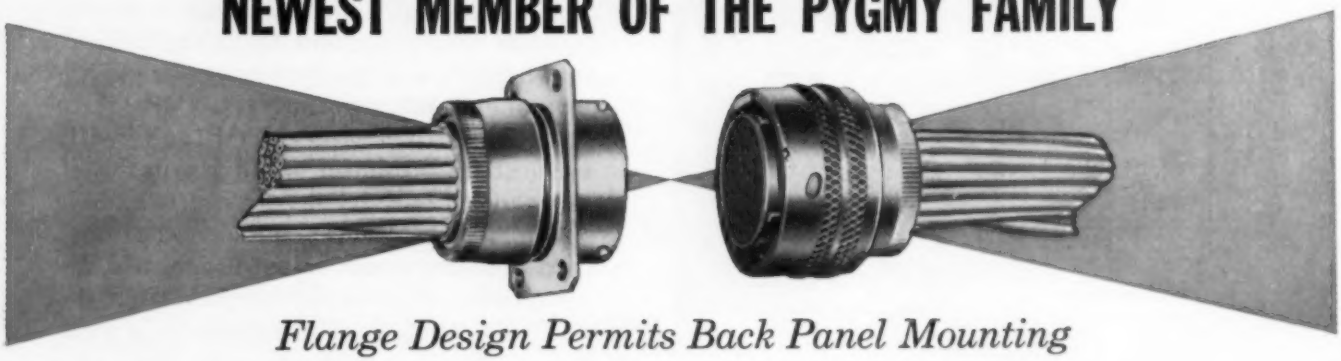

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continually being improved to yield substantial performance increases that will enable us to exceed original design specifications. These changes are being introduced into the *Thor* in an orderly, programmed way.

The growth of scientific knowledge and practical experience are continuous processes, and at best fit uncomfortably into the tidy packages called development cycles. Problems of propulsion, guidance, reentry and space medicine are no respectors of names like *Thor*, *Atlas* or *Titan*. These problems simply exist, tantalizing and frustrating the planners and the engineers. They must be solved by whatever means and resources can be brought to bear on them.

AFBMD's various projects in ballistic missile development and space research are likewise closely interrelated. Borrowers all, these projects will continue to share technology, hardware and facilities as the Air Force extends its space age capabilities toward the goal of piloted space flight.★

Ramo-Wooldridge Veeps Given New Roles

Four Ramo-Wooldridge Corp. vice presidents have had a shift in responsibilities.

Dr. Ralph P. Johnson, formerly vice president, research and development, now heads the General Electronics Group of the divisions. His duties include direction of all research, engineering, manufacturing and administrative activities of the company except those of Space Technology Laboratories and the Thompson-Ramo-Wooldridge Products Co., both of which will report to the president.

Former vice president and director of the Communications Division, Dr. Burton F. Miller, becomes vice president and director of advanced systems planning and, with Drs. Wooldridge and Ramo, will plan and arrange the corporation's entry into new product areas.

Milton E. Mohr has been named vice president-engineering, and will be responsible for the Control Systems Division, Communications Division and the Electronics Instrumentation Co. He was formerly vice president and director of the Control Systems Division.

Irwin A. Binder, vice president, manufacturing, will have direct responsibility both in Denver and Los Angeles of the Manufacturing Division.

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Principal wear surfaces of missile turbine shafts Flame-Plated by LINDE with tungsten carbide are indicated by arrows.

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Progress Report:

Big Challenge: Missilizing Our Navy

by RAdm. K. S. Masterson, U.S.N.*

IN THE PAST FEW YEARS IT HAS BECOME more and more obvious that guided missiles are dominating the scene to a greater degree with each passing day. This is true throughout the Department of Defense, the Joint Chiefs of Staff and all the Services.

It was during World War II that the requirement for guided missiles in the Navy was born—primarily as a result of the highly successful Japanese Kamikaze attacks. The immediate requirement was for a fleet defense surface-to-air guided missile, and this led to the Navy's highly successful—and then highly secret—*Bumblebee* program, from which evolved today's naval surface-to-air *Terrier, Talos,* and *Tartar* missiles.

In view of its versatility, the Navy has a requirement for all categories of guided missiles. (Surface-to-air, air-to-air, air-to-surface, and surface-to-surface). This is because the Navy goes where the fighting is—taking her missiles, launching platforms, and airfields for both offensive and defensive operations. In addition to the requirement for all categories, the Navy must have missiles of different sizes within a category because of the difference in size and mission of ships and aircraft.

Naval weapons systems must function in the very special *environment* of ships at sea. This means that our missiles must inevitably be more complicated and specially designed; and therefore, sometimes become more expensive than similar missiles.

• **Problems of ships at sea**—The Navy is especially proud of its achievements in guided missiles—not only because of the technological advances made, but because these achievements were made in the face of very special problems—problems created by the environment of ships at sea. The Navy has the problem of limited space aboard ship.

Missiles must be comparatively small for stowage in ships' magazines, and must live in close proximity to their launchers. This is not true of land-based missiles. Navy missiles must be safe in storage, because we live with them aboard ships at sea. We can't set up launchers in great numbers, and those we have must be capable of rapid reloading with a minimum of readiness time.

Our missiles must be capable of stowage in sufficient numbers in confined magazines to provide an effective combat capability. This imposes severe electronic and engineering problems upon our areodynamic engineers, who must get the absolute maximum out of small and folding wings and the aerodynamic body of the missile. We have the special problem of a launching platform in constant motion in all axes, and stowage under conditions of severe vibration.

We have the problems of highly corrosive salt spray, and of operating in a hot climate one week and a very cold one the next. And since we can carry the missiles only in limited quantities, we must have an extremely high order of reliability. Finally, in the case of our aircraft missiles, we have the very special problem of repeated catapult take-offs and arrested landings, imposing a unique requirement for ruggedness of circuitry and missile structure.

Even in funding, the Navy has a somewhat unique problem. In this connection, it is important to realize that the Navy, within the total budget, has to support a combat capability on land, on the sea, *under* the sea, and in the air. No other service has such a broad demand on its overall budget. On top of this, *nuclear* as well as *conventional* capability must be provided.

Despite these problems, we still have a good missile program, and we *do* have a significant missile capability at sea today—and it will improve steadily as time goes by. This program supports current and future operational requirements of our operating forces at sea.

• **Air defense requirements**—Two categories of missiles are being developed, namely: surface-to-air and air-to-air.

In the surface-to-air category, the Navy has three projects—*Terrier, Talos* and *Tartar*. These are related in their basic operational techniques, but markedly different in size and performance characteristics.

Terrier is launched with a solid rocket booster. After launch, the booster separates and the missile's solid-rocket sustainer is then ignited and maintains the missile at speed. *Terrier* is a beam rider; the same radar which tracks the target also supplies the beam which guides the missile to the target.

Terrier is in the fleet on the cruisers Boston and Canberra and the destroyer Gyatt. In addition, two aircraft carriers, three cruisers and seven frigates, either being converted or constructed, will carry *Terrier*. Shipboard *Terriers* are selected from the magazine, loaded, trained, elevated, and fired automatically.

The next of the surface-to-air missiles is the *Talos*. *Talso* is a long range missile, and provides tremendous killing power in its role of fleet air defense. It is going to exert a big impact on fleet operations.

The first ship to have this capability is the cruiser Galveston. Additional cruiser conversions are planned. The first nuclear cruiser, Long Beach, will be *Talos*-equipped. The third missile in this category is the newest and smallest-*Tartar*. *Tartar* is designed for use from ships as small as destroyers, and for secondary battery use from cruisers.

Air-to-air missiles are becoming the primary fighter aircraft armament,

**Director, Guided Missile Division, Offices of Chief of Naval Operations.*

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. . . Navy challenge

contributing vitally to effective fleet air defense. As the inner defense is taken over by surface-to-air missiles, missile-armed fighters will push the defense perimeters farther and farther outward —making it increasingly difficult for enemy bombers to penetrate to weapon-release points.

A most successful operational air-to-air misile is *Sidewinder*. It is effective to altitudes over 50,000 feet. Squadrons are deployed with this weapon in the Mediterranean and in the western Pacific.

Another air-to-air missile in the fleet is the *Sparrow* I, a supersonic beam rider. Navy is pursuing an orderly course of design improvement in this air-to-air field, and the next member in the fleet will be *Sparrow* III.

• **Attack requirements**—The projects mentioned so far relate to air defense. The following are plans directed toward the attack requirement.

The *Petrel*, an air-to-surface missile, is launched from aircraft, flies to a point near the target, and then drops a torpedo which attacks the surface target. Recently production was completed, and the missile and its aircraft were transfered to the reserve fleet.

Bullpup, another air-to-surface guided missile, is a highly accurate weapon system which will materially increase the effectiveness of light attack aircraft in tactical missions. It is scheduled to become operational this year.

This brings us to the surface-to-surface category. Here the Navy can make a particularly significant contribution to our total offensive military readiness.

The surface-to-surface missile lends itself to either surface-to-surface ships or submarine employment. With essentially no supporting forces, individual guided missile submarines, nuclear-powered, can operate in the face of strong defenses and in widely dispersed areas for indefinite periods of time.

To be operationally and economically acceptable, surface-to-surface missiles of intermediate or long range must carry nuclear warheads; therefore, they can be either deterrent weapons or weapons for specific tactical uses. The Navy has been developing surface-to-surface missiles of two types —air breathing and ballistic. Navy air breathing missiles consist of *Regulus* I and *Regulus* II.

Regulus I is currently available for deployment and use from submarines, cruisers and carriers. There have been many successful flights of *Regulus I*.

Regulus II has been developed as

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For technical data on the new Cherry "800" Monel and other Cherry High Clinch rivets, write Townsend Company, Cherry Rivet Division, P. O. Box 2157-Z, Santa Ana, Calif.

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. . . Navy challenge

a direct product of the *Regulus* I program. *Regulus* II is now being flown in flight tests at Edwards Air Force Base. It flies faster, and for greater distances, than *Regulus* I. Like *Regulus* I, it will be lanuched from submarines and cruisers.

• **Ballistic missiles**—*Polaris*, the Navy's Fleet Ballistic Missile, will be a sea-based, intermediate range missile for use against land targets. Current development is aimed at achieving a solid propellant rocket capable of ranges up to 1,500 miles.

Polaris is a system of which the Navy can speak with great pride. When it goes to sea, it will have the qualities of a practically invulnerable missile system.

It will be mobile and capable of concealment. It will be fired from beneath the sea—its firing position invisible, and unknown to the enemy. It will involve no real estate question. It will not be provocative—it will simply be ready.

The Navy's missile launching sites are moved to where they are needed. This simply means that the Navy provides the nation with a *minimum of launching sites to cover a maximum of target areas*. Seventy per cent of the world's surface is water. Thus, with ships, submarines, and carrier aircraft, the Navy provides a mobile missile platform which this country can count on almost anywhere in the world to promote and maintain peace, or to fight any type of war that may eventuate.

The Navy's guided missile program is designed to provide a continuing combat readiness in the fleet at sea now; and, at the same time, to provide for the weapons of the future as the state-of-the-art progresses and the enemy threat increases.

Guided missiles are just infants, but they're evolving fast! They've been called rockets with a brain. Let's hope they never learn to think! But, then, perhaps, thinking missiles would all join forces to combat the monsters we humans have created.

We in the Navy are proud of our missile program. We are adapting missiles where they can do the most good in modernizing our fleet—ships and aircraft—for control of the seas; the Navy's main mission.

The Navy has many different jobs to do, but it is only one member of the defense team. The Army, the Air Force, and the Marines are all part of the team and each service has to do its job if the U.S. is to maintain its strength.

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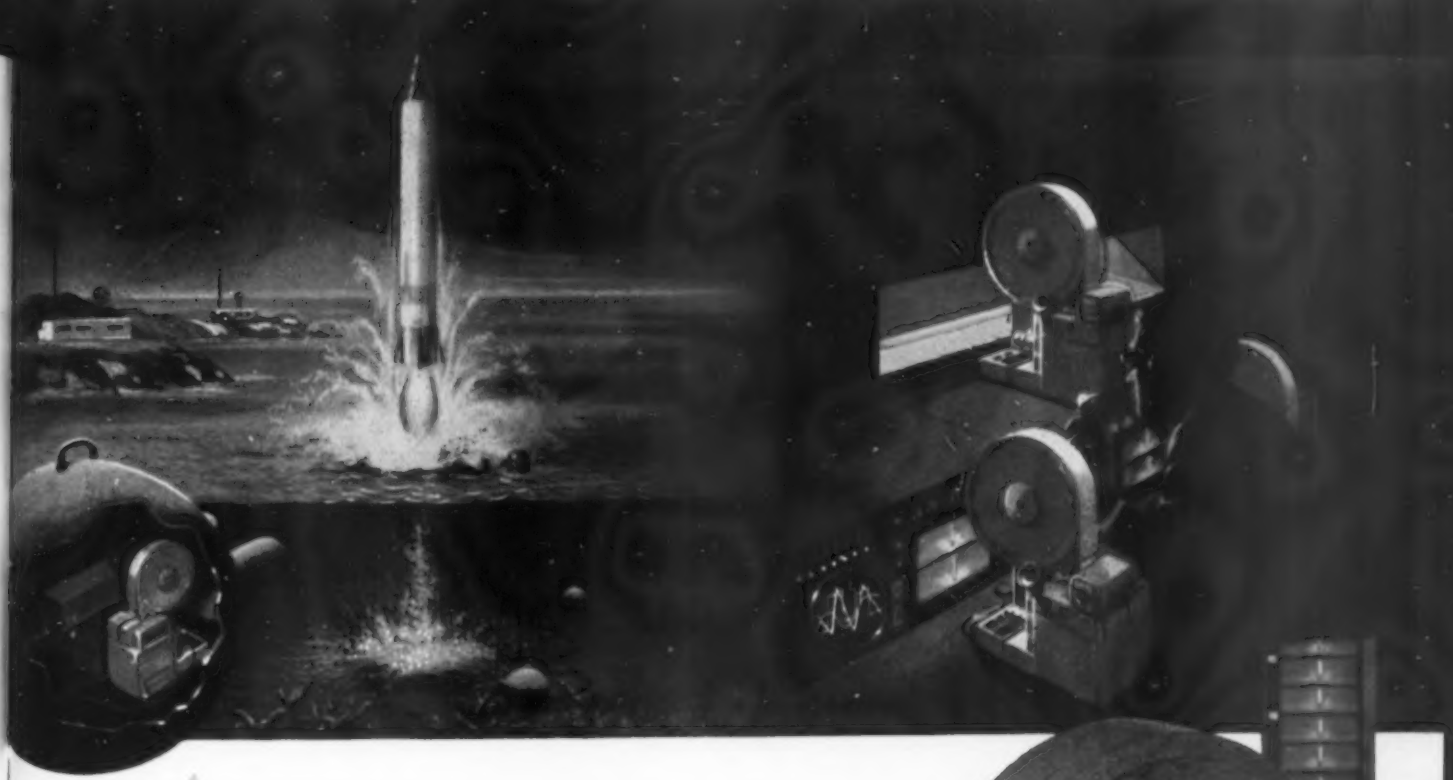

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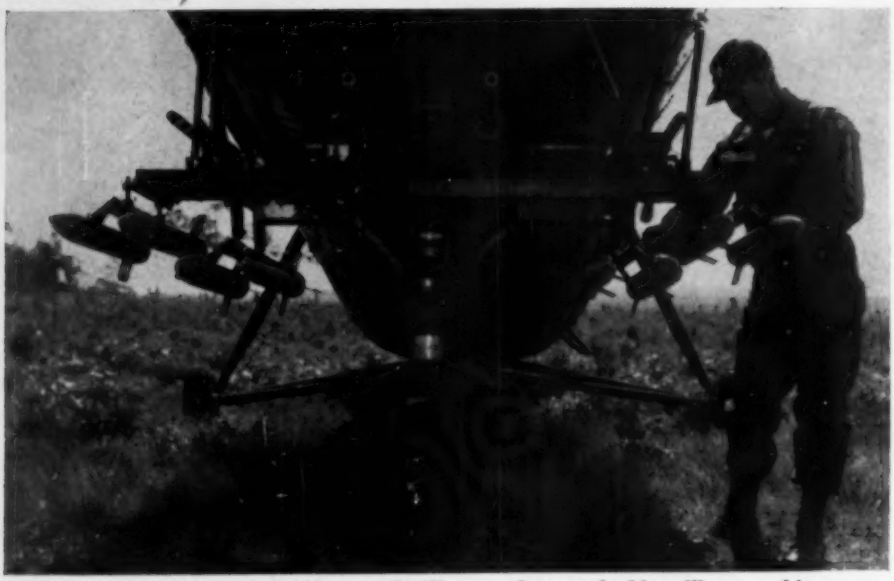
Progress Report:

Army Pushing "Brush-Fire" Missiles



VERTOL H-21C mounting 80 mm Oerlikon rockets and .30 caliber machine guns. Tests were conducted at the Army Aviation School, Fort Rucker, Alabama.

PRESENTLY UNDERGOING TESTING is the Sikorsky H-34A. Armament includes forty 2.75 inch rockets, two 5-inch rockets, two 20-mm cannon, and six machine guns.

IN A DEMONSTRATION AT WHITE SANDS, this Sikorsky H-37 is teamed up with two other H-37's, to transport an *Honest John* with launcher and jeep-trailer.

by Raymond M. Nolan

PROGRESS DURING THE PAST YEAR for the Army can quite rightly take other forms and names, such as consolidation and planning. Although a number of new missiles were shown, they had in fact emerged as weapons before the year began.

The Army obviously had ample capability to do more. Certainly, the excellent development teams at the Army Ballistic Missile Agency, Jet Propulsion Laboratory, and Redstone arsenal have proved that they are capable of taking any assignment and turning it into hardware.

However, approvals of new projects in the past year have been few. One of these was an invitation to participate in the lunar probe program.

In the field of tactical weapons, claims are made that excellent progress has been made, but in most cases there are qualifying circumstances to the release of information on new missiles. For example, the *Sergeant* was unveiled during 1958, although press announcements reportedly had been prepared for almost a year.

In the space field, the *Jupiter-C* made its mark, but it wasn't too different from the Project Orbiter concept that was proposed in 1955. The actual *Jupiter* missile has had a slowdown in testing—due in part to gearbox troubles—but also due to a shift in emphasis to *Jupiter-C* and to the re-entry problem.

Since funding of the *Jupiter* is now an Air Force problem, no mention is made of it in the Army budget. The largest single missile item, instead, is $109 million for the *Redstone*, the first true U.S. operational ballistic missile.

In the anti-missile area, the *Nike-Hercules* seems about to replace the *Nike-Ajax* as first line of anti-aircraft defense, and the *Nike-Zeus* won the choice for the anti-missile missile over the Air Force *Wizard*. However, funds for *Nike-Zeus* production have been severely limited (m/r July 21, p. 32)

In the field of planning, the *Pershing* is probably the most exciting prospect, but it is still to early in development to count as a weapon. Observers are watching this first attempt by ABMA to relinquish systems responsibility to a prime contractor.

Project *Mauler* is another missile still in the planning stage. Reported to be a successor for the 40 mm anti-aircraft shell, it also will be used in area defense after attack by larger missiles.

A contract has been let for a follow-on to the *Little John;* and another version, called the *Chopper John* because it is helicopter-borne, is in the works.

• **Engineering**—Under the heading of engineering progress, probably the most significant development within the past year has been the emergence of the helicopter as a missile platform. At the recent AMMO (Army Mobile Missile Orientation) staged at White Sands, (m/r July 7) the helicopters stole the show.

The use of helicopters to carry missiles had its beginning in 1956. The Commanding General, Continental Army Command, authorized the Army Aviation School at Fort Rucker, Alabama, to conduct a series of experiments to determine the feasibility of adapting different weapons, including missiles, to helicopters both of the present type and more advanced types expected in the future.

The feasibility studies, as far as missiles were concerned, were an unqualified success, and for the past year, the Army has been asking for, and getting, a number of proposals from industry. So far, no word has been released about contracts in being, but undoubtedly there are a number of studies going on at the present time.

The helicopters at White Sands carried an impressive array of missiles, ranging from 80 mm Oerlikon rockets to 5-inch anti-tank, anti-submarine rockets. Because of the extreme maneuverability of the 'copter, the usable range and deployment of the missiles was greatly increased. It seems only a matter of time until larger missiles are mounted and used.

The French have already demonstrated the feasibility of larger rockets by mounting SS11 rockets on their *Alouette* helicopter. Since our *Dart* missile is very similar to the SS11, it should only be a matter of time before helicopters are carrying them as tactical weapons.

As a missile carrier in close-in tactical operations, the helicopter has no equal. The Sikorsky H-37 has demonstrated that it can carry the *Honest John* with no trouble in a sling arrangement.

With the global situation being what it is, and "brush-fire" wars the most likely kind to occur, helicopters firing rockets might very well be the only type of missile warfare we will engage in for some time to come. In any event, the fact that we have extended the range and deployment opportunities of small missiles means that a new type of weapon system is in existance—a firing platform for small and medium tactical missiles.

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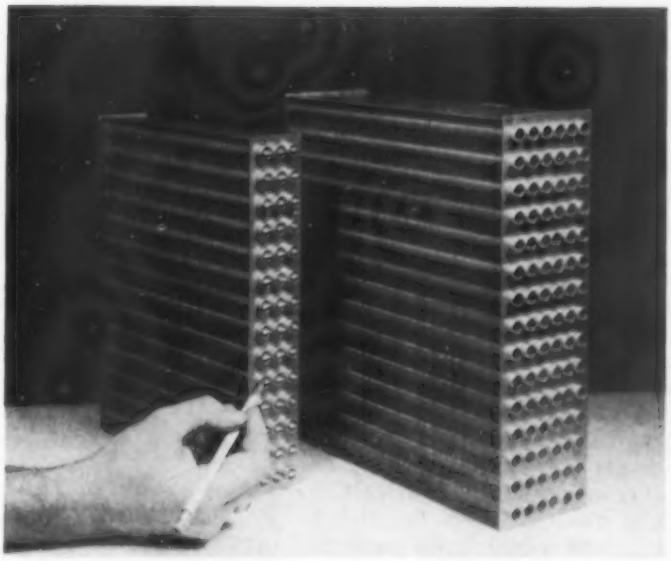

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Progress Report:

Why USAF Plans Billions For Defense

by Maj. Gen. Ben I. Funk*

OUR COUNTRY'S TOP PRIORITY defense job today is the Air Force Ballistic Missiles Program. These missiles will be our counterpunch tomorrow, as the manned bomber is now.

We have a goal. We must achieve it. That goal is for the United States to have a completely dependable and fully operational team of ballistic missiles, ready for our protection as soon as humanly possible.

Nothing less will defend us. But in achieving this, the impact of the program upon our national economy will be beyond prediction. Many will be helped. Some few will be hurt. All of us will be affected.

The size and complexity of the problem is staggering. Its solution requires far more than accelerated research and development. We need to do more than simply to accelerate research and development to improve present weapons systems and to design newer, better ones.

We must, additionally, have the means for necessary production in quantity—tooled, trained and ready. There must be logistic support for R&D, procurement, production, and for operation and training.

The Ballistic Missiles Office of Air Materiel Command has that essential responsibility: for procurement, production, logistic support.

These three functions make up one big assignment. Even now, in its early days, our program has made profound changes in our national industry. It is revolutionizing the entire business of defense. Directly and indirectly it is, even now, involving very many thousands of both large and small firms, and literally uncounted thousands of American wage earners.

• **Billions for defense**—At the money level alone, USAF's ballistic missiles program is spending over $1.3 billion annually for our defense dollars.

It has been less than four years since the first official Air Force order was issued for research and development of an ICBM. This decision was a direct outcome of the thermonuclear breakthrough in 1953, when the making

of a high yield hydrogen warhead small enough for practical missile use became feasible.

Concurrently with the establishment of the Western Development Division of the Air Research and Development Command—today's Air Force Ballistic Missile Division—under the command of Major General B. A. Schriever, the Air Materiel Command set up its Special Aircraft Project Office, now the Ballistic Missile Office.

Thus AMC became a part of the unique management team, which today includes also the SAC-MIKE office of Strategic Air Command, and the Space Technology Laboratories of the Ramo-Wooldridge Corporation.

This management complex, made up of offices from three major USAF commands and an experienced civilian technical firm, is providing, for the first time in military history, a weapons system with skilled direction from the first concept through R&D, procurement, production, creation of test and industrial facilities, the building of launch complexes, the establishment of logistic support, and the training of technical and operational personnel up to the final point where a combat force can take over the missile for actual use.

• **Many take part**—Back in 1954 there were only a handful of people in the ballistic missile program. Today there are more than 2,000 military and civilian personnel, hand-picked for their specialized skills and experience, working literally day and night . . . and the number of people is growing, the working hours keep getting longer. Even for those within the team it is sometimes difficult to comprehend fully the magnitude of the program.

For example, consider our *Atlas*, *Titan*, and *Thor* missiles. They are built by a number of major associate prime contractors. Convair, Martin, and Douglas are responsible for the air frames and production assembly. Propulsion systems come from Rocketdyne Division of North American Aviation, and from Aerojet-General Division of the General Tire and Rubber Company. Sundstrand furnishes auxiliary power supplies. Guidance and control systems are produced by General Electric, Western Electric, American Bosch Arma, and AC Spark Plug. Burroughs and Remington-Rand build the computers. AVCO and General Electric provide the nose cones.

Fifteen prime contractors are required for these three missiles. One of these primes alone is subcontracting work to more than 8,000 other firms.

Present indications are that about 55,000 workers are employed by prime contractors under the program. To these can be added about 35,000 others, employed by major subcontractors. All are employed by firms that are holding missile contracts. When the second, third, and fourth tier subcontractors are considered, there must be many more than 100,000 American workers directly affected economically.

Geographically, the program is really nationwide. Prime contractors and major subcontractors are located in 25 states and the District of Columbia. They are on the Atlantic Coast, the East, the Midwest, the South, the Southwest, the Farwest, and the Pacific Coast. Lower-tier subcontractors are found in practically every state.

Small business also has a big place

**Ballistics Missiles Manager Air Materiel Command.*

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. . . why USAF plans billions

in the program. Small firms cannot be called neglected, either dollar-wise or in numbers.

There is a common misconception that USAF's big missiles are being made by only a few large aircraft companies. This is simply not so. Many small companies are now participating actively. More will join in the future.

Take the case of Douglas at Santa Monica. Douglas officials are the first to point out that their company has subcontracts to 8,473 smaller businesses, which contribute essential items to the program.

Nowhere in the program is there a case of "one contractor—one weapon."

• **Small business too**—Since our associate prime contractors must team together, it is obvious that they must also call on small concerns to participate. Each needs the other. And Air Force needs them all.

This small business participation is big business in itself. More than 27 cents of every Air Force dollar spent on ballistic missiles is going to small business. That much is known. That amount can be traced. How much more trickles down from sub-sub-contractors is beyond convenient estimation.

Six months ago—as of December 31, 1957—USAF had paid more than $1.3 billion to prime contractors holding contracts for R&D and for procurement and production of missiles. Of this amount, almost 21 percent—$269 million—passed directly from prime contractors to smaller businesses for goods and services. Another 7 percent —$91 million—could be traced to second and lower tier small business contractors. These $360 million equal 27.7 percent of the total AF money spent for ballistic missiles.

At the beginning of the missile program, extensive subcontracting to small business was impractical. There were three main reasons for this.

First, small business was actively engaged in producing the components of manned aircraft, components needed for supplying the production lines rolling out aircraft in quantity. This was a job they knew well, under contracts and circumstances with which they were familiar.

Second, the ballistic missile program was then one of initial research and development, involving new hardware prototypes in small numbers. Quantity production of big missiles was only in the preliminary planning state. The time had not yet come where small business could help the program to advance.

Third, from USAF's point of view, there was security to be considered. R&D was then highly classified. In the national interest it was necessary to hold down the number of persons and companies involved.

Yet even so, small business was getting an indirect share. There was, for instance, the matter of some $450 millions invested in the industrial base for R&D, testing, and production. This included $115 million supplied by prime contractors from their corporate funds, plus $235 million in USAF industrial facilities and public works monies. This spending produced new buildings, new laboratories, new machine tools, and new test centers, equipment, and facilities.

In our free economy it is literally impossible to spend $450 million without many of those dollars going to small firms.

Somebody has to put the windows in the new lab building; it is usually a small glazing firm that gets the job. Somebody has to deliver the special new equipment to the new lab; normally a local trucker does the pick-up and hauling. Somebody has to lay the blacktop for the parking lot; generally a local contractor has the low bid.

Air Force makes very sure that America's vital small companies participate in the ballistic missiles program. Each missile contract carries a clause which requires that the prime contractor do the maximum amount of subcontracting feasible.

AMC's Ballistic Missiles Office now has a separate Small Business Office. This has been set up specifically to assist small companies. It helps fit them into the picture where it will be best for all concerned.

Long before production lines were set up, small business was working on Air Force ballistic missiles. Once full production is established, small business will earn a larger share of defense dollars.

That share, up-to-date, has not been small. Consider these typical examples: Convair is building *Atlas*. About 37 percent—$105 million—of the *Atlas* contract has been subcontracted to almost 2,900 different businesses.

• **Who's doing it**—*Thor* is on the assembly lines at Douglas. Of the overall *Thor* dollars, Douglas has spent 23 percent—$18 million—with more than 8,000 smaller firms.

Martin is building the *Titan*. More than 1,500 small companies will earn 27 percent—$35 million—of the *Titan* contract.

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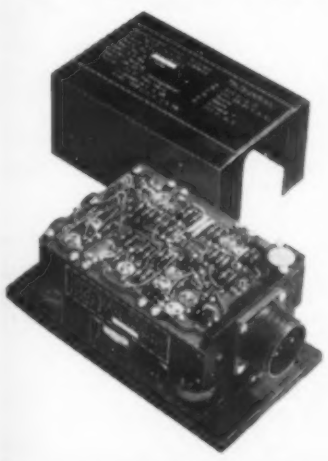

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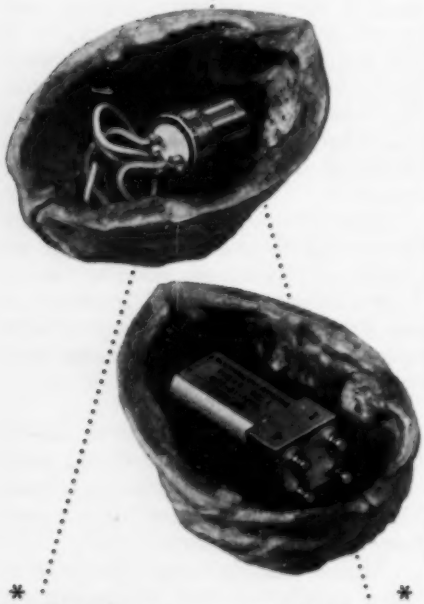
miniaturization in a nutshell



STATHAM MODEL P222 flush diaphragm pressure transducers. DIMENSIONS: .25" diameter x .47" long. WEIGHT: 3 grams, approximately. RANGES: 0-10 to 0-200 psia, psig, or psid; ±5 to ±25 psid. NON-LINEARITY & HYSTERESIS: Not more than ±1% fs. TRANSDUCTION: Resistive, complete bridge; Statham unbonded strain gage.

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. . . USAF plans

Propulsion systems for *Atlas*, *Thor*, and *Jupiter* are being built by Rocketdyne. About 4,000 small business are getting 20 percent—$45 million—of the Rocketdyne contract.

R&D and procurement and production have taken a major share of the amounts spent on ballistic missiles so far. Now, with our missiles approaching operational status, something new is looming on the economic horizon.

This is the logistic support question.

Operation and maintenance of missiles is far more difficult than that demanded by manned aircraft. And logistic support is more important to the ballistic missile than it is to any weapon ever developed by man.

Part of this is due to the time-compression inherent in missile warfare. Even our fastest jets take long hours to reach far-off targets. A missile spans the same distance in short minutes. Speed and precision are more important than ever before. Both are costly.

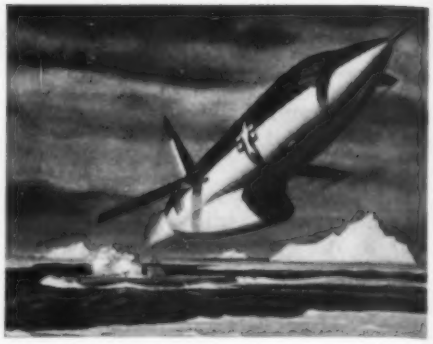
Reliability has become a critical factor. Once a missile is fired, nothing can be done to correct mistakes or omissions made on the ground before the launching. Supply and servicing create problems never before encountered, let alone solved. Completely different methods of determining needs and supplying parts, material and labor are required.

• **Ground support**—Then there is the disproportionate cost of ground support. If, for example, there are ten *Atlas* missiles at a launching site, their value will represent less than 20 percent of the total site cost. Spare parts will come to another 10 percent. Technical facilities will represent 30 percent. And 40 percent of the dollars invested will be in ground support equipment.

Logistic problems for AMC are more than doubled in this new age of missiles. Both manned aircraft and ballistic missiles must be supported to the fullest extent possible. Automation and electronics have been called in to help solve this puzzle.

Within a few months, in our Directorate of Ballistic Missiles at Norton Air Force Base near San Bernardino, a new AMC system will be in full operation.

As the brain of this system there will be an Electronic Data Processing Center. Here a giant computer will be linked, by a separate communications net, to the operations and logistics sections of our working missiles. Operating squadrons, storage sites, contractor supply and maintenance, and Air Force



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Test Equipment Engineer. Requires E.E., or Physics Degree and at least 2 years experience in this or related field. (Desirable: broad background in electronics design with emphasis on digital computers or microwave systems.) To join in the design of complete checkout systems for missiles and associated subsystems.

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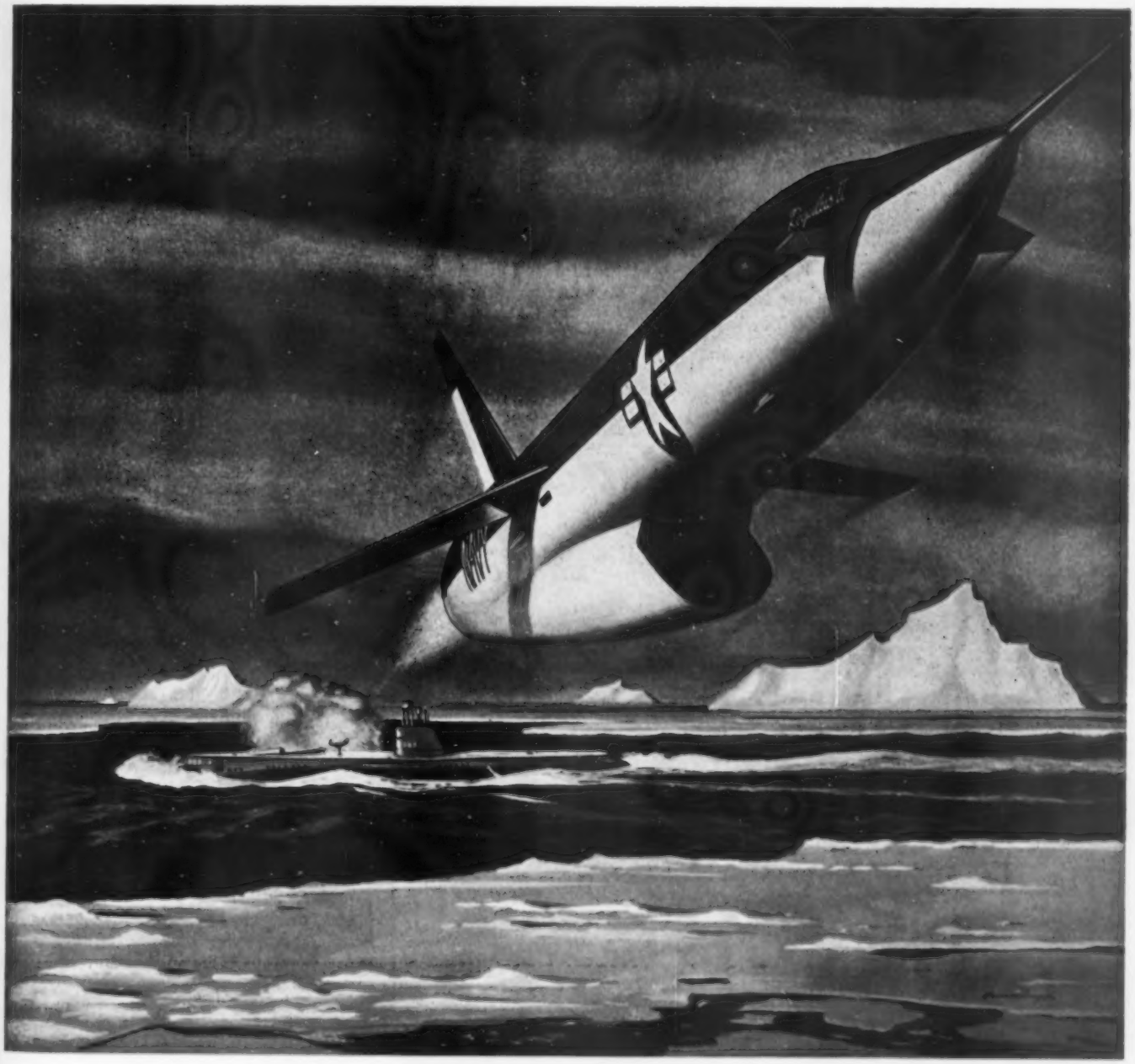

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. . . USAF plans

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Without the Electronic Data Processing Center and its system, our missile support program could bog down in endless paper work, result in mountains of unused parts, and tie up uncounted manhours. With EDPC we can meet the logistic demands of the missile age.

In the process of developing missile support systems, we should discover new concepts and methods which could prove of great value to American industry.

The Air Force ballistic missiles program promises to be one of the most radical developments we have seen. The coming of steam power, of electricity, of internal combustion engines, and of electronics and atomics, all made vast changes in our world. Missiles can prove as important as any of these.

Missiles are much more than just new weapons. The rocket, like the airplane, is a revolutionary vehicle. It is opening up an absolutely infinite new field as a transportation and communications tool for mankind.

Big as the program is now, it will be bigger in the future. It must be so. Missiles are the future.★

Space Agency Bill Awaits Presidential Okay

The House and Senate last week quickly approved and sent to the President, the compromise bill setting up the new civilian National Aeronautics and Space Administration. The new agency, using the National Advisory Committee on Aeronautics as a nucleus, will function under a nine-man council headed by the President and an administrator with broad powers. The administrator will be appointed by the president. Dr. Hugh Dryden, current head of NACA, is the man named most likely to get the nod.

The bill in its final form had a provision deleted which would have provided insurance of contractors working on space projects, but House Majority Leader John McCormack, who is also chairman of the House space committee, inferred that new legislation may be forthcoming. The bill also provides that small business "will be able to participate equitably" with the industrial bigs, and grants certain commercial patent rights to industry.

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Progress Report:

Science

ENORMOUS PROGRESS has been made last year in our large ballistic missile programs, and an increasing rate of activity promises even more reassuring and gratifying results in the period ahead.

We have by now had such repeated and definitive confirming scientific data on all of the techniques and fundamental design points—on structures, propulsion, re-entry, and on guidance and control—as to leave no doubts concerning the scientific basis for our large missile technology and plans now in progress.

We have also had enough success in our first year of full-scale flight tests as to be able to carry every part of the program into the design-finalizing and reliability-improvement operation phase.

• **Missile age preparation**—We have been preparing for this final phase on a scale without previous precedent. A mere handful of missiles turned out in a year can hardly act as a deterrent against an aggressor nation, nor should we be frightened by such a capability in their hands.

What is needed is much more than a scientific demonstration to show that these things can be done, and that a practical embodiment is possible. A substantial number of missiles is needed, standing ready, with high reliability inherent in their detailed design; with training and handling programs that have reached positive and tested fruition; with logistics, spares and maintenance backup's. Only such an operational capability as described is meaningful.

But to attain these things means large quantities of hardware to make possible the detailed product development of each component, and to provide assurance of proper design when these components interact in major subassemblies.

We need a vast amount of component testing, analysis, and detailed design refinements. Over-all systems tests, both "hold-down" or captive, and flight tests are required covering a wide range of conditions which might exist

Boosts Ballistic Missiles

by Simon Ramo*

for various flight operations.

• **Present production**—To make possible such a scale of operations, the Air Force program on *Thor, Atlas,* and *Titan* had to be broadly planned from its inception, and long leadtime steps taken well before the design could be jelled.

Today every subsystem, be it guidance, re-entry nose cones, or rocket engines, is pouring from production lines.

Every flight test that has been made has involved equipment from these lines. When a missile flight is analyzed, or a static stand's results are investigated, the considerations include not only the fundamental design, but the relations of function to manufacturing tolerance, quality control of factories, check-out procedures, and simultaneous development of all of the measuring apparatus involved in the operating procedure.

In developing missiles, we are also developing the industry, the facilities, the capability of reproduction of hardware, and the teams and procedures in operation.

Even the test flight range itself is being pioneered as to its sophistication, as well as its distance, by these large programs. Every test result enables us to take another step in the tightening up and bedding down of this large complex of men and machines.

• **Future capability**—The period immediately ahead will see demonstrations to the fullest ranges and the highest accuracies of the largest payloads of which these systems are capable. It will also see the completion of the creation of a major new technology in the U.S. With this industry established, and with the engineering techniques firmly rooted, the U.S. will then be in a position to take other steps into space, based on the availability of really large boosters.

By engineering extensions that in themselves will be much more straightforward than has been true of the first steps in providing for a truly long-range ballistic missile capability, we shall be able to launch with reliability and relative ease heavy payload satellites. We shall also be able to do a great deal in pursuing bio-medical space experiments; Lunar, Martian, and Venusian probes; and even commence the many steps of making man a space traveler.

**Dr. Ramo, president, Space Technology Laboratories (a division of the Ramo-Wooldridge Corporation), is also a member of the board of directors of Thompson Products, Inc., and of Pacific Semiconductors, Inc. The Space Technology Laboratories has over-all technical supervision and weapons system engineering responsibility for the USAF Ballistic Missile Program, including the intercontinental* Atlas *and* Titan, *as well as the intermediate-range* Thor *ballistic missiles. Dr. Ramo is "chief scientist" of this program. He is also author of two major textbooks widely used in the nation's universities and by practicing engineers: "Fields and Waves in Modern Radio" and "Introduction to Microwaves." Dr. Ramo teaches several graduate courses at the California Institute of Technology for doctorate students.*

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Rochester Division, Rochester 3, N. Y.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

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contracts

NAVY

By District Public Works Office, Eleventh Naval District:

Cory and Longworth Inc. received $465,000 for construction of interim guided missile facility.

Manco Construction Co. received $291,100 for construction of turbo-jet engine test cells, naval air missile test center.

AL-CO Co., Inc. received $961,452 for construction of various bldgs., Naval missile facility.

James Stewart Co. received $162,950 for construction of guided missile support facility.

By Naval Research Laboratory:

Royal McBee Corp. received $51,740 for digital computer.

Bendix Computer Division, Bendix Aviation Corp., received $82,799 for medium speed digital electronic computer system.

By Bureau of Ordnance:

Corning Glass Works received $400,000 for production of Pyroceram missile radomes.

Bjorksten Research Laboratories received $75,000 for research on low-fluidity refractory materials.

Cornell Aeronautical Laboratory received $49,718 for research of ceramic materials.

By Bureau of Ships:

Control Data Corp. received $600,000 for large-scale computer of advanced design.

ARMY

By Purchasing and Contracting Office, Engineer Research and Development Laboratories:

LOX Equipment Co. received $47,789 for LOX 25-ton trailer.

Charles Payne & Associates received $53,816 for study and design of one horizontal standby shelter, *Jupiter* system.

By Engineer District, Mobile, Corps of Engineers:

Butler & Cobbs received $194,877 for construction of interim test facility for solid propellants at Redstone Arsenal.

By Engineer District, New York, Corps of Engineers:

Vincent J. Licata received $195,419 for construction of rocket storage checkout and assembly building addition.

By Boston Ordnance District:

National Research Corp. received $74,680 for research and development study.

Sylvania Electric Products, Inc. received $99,995 for research and development study.

By Engineer District:

Robert E. McKee, General Contractor, Inc. received $642,300 for flight determination laboratory; $624,650 for communications building laboratory; $2,326,800 for radar park facilities.

Hugh McMillan, Inc. received $111,136 for ABMA instrumentation facilities.

By Engineer Division, New England Corps of Engineers:

Manzi Electric Corp. received $64,136 for construction of flood lighting and alarm systems for *Nike* batteries.

By Purchasing and Contracting Div., White Sands Missile Range:

Bendix Pacific Div., Bendix Aviation Corp., received $199,263 for digital meteorological data measuring and logging system.

American Machine and Foundry Co. received $229,880 for targets.

Lee Electric Construction Co. received $23,998 for power facilities for FPS-16 radar unit.

Wayne George Corp. received $116,000 for digital data recorder.

Brush Instruments Div., Clevite Corp., received $67,725 for recording systems.

By Engineer District, Kansas City, Corps of Engineers:

Martin K. Eby Construction Co. received $5,659,696 for construction of four *Nike-Hercules* missile areas; $93,900 for construction of rocket storage.

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. . . contracts

By Ordnance Missile Command:

Birmingham Gas Heating and Air Conditioning Co., Inc. received $86,774 for installing a high and low temperature conditioning system for testing large jatos at various temperatures.

Radio Corp. of America received $321,922 for complete closed circuit television system.

By Purchasing Division, Quartermaster Activities, Cameron Station:

R. E. Lee Electric Co. Inc. received $37,210 for installation of combination tactical alert-fire alarm systems at *Nike* sites.

By Engineer District, Chicago, Corps of Engineers:

Siesel Construction Co. received $699,743 for construction of additional facilities at special AAA sites.

Lee Construction Co., Inc. received $766,000 for construction of additional facilities at special AAA sites.

Siesel Construction Co. received $711,434 for construction of additional facilities at special AAA sites.

Fischbach, Moore & Morrissey, Inc. received $50,732 for construction of anti-intrusion system at special AAA sites.

Abbot Construction Co. received $251,882 for construction of *Nike* guided missile field maintenance shop.

By Engineer District, Philadelphia:

Malan Construction Corp. received $2,204,123 for construction of conversions with related site improvements and utilities at 12 special AAA sites.

By Corps of Engineers, Office of the District Engineer, San Francisco District:

Newbery Electric Corp. received $32,580 for modifications and improvements to launcher areas.

By Corps of Engineers, Office of the District Engineer, Washington:

Grunley, Walsh & Blanche, Inc. received $815,214 for construction of modification of tactical facilities at *Nike* sites.

Malan Construction Corp. received $350,558 for construction of modifications of tactical facilities at *Nike* sites.

Thomas W. Yoder Co. Inc. received $519,523 for construction of modifications and conversion of tactical facilities at *Nike* sites.

Tuckman-Barbee Construction Co., Inc. received $246,700 for construction of *Nike* guided missile field maintenance shop at Fort Belvoir.

By Ordnance District, Los Angeles:

Gilfillan Bros. Inc. received contracts totaling $189,928 for depot replenishment repair parts for the *Corporal* missile system.

Firestone Tire & Rubber Co. received $163,000 for replenishment repair parts for guided missile, artillery M2 and related ground handling equipment.

Townsend Engineered Products received $59,895 for design and development of a ground fire suppression kit for helicopters.

Aerophysics Development received $49,334 for *Dart* antitank guided missile.

Douglas Aircraft Co., Inc. received $68,900 for repair parts for *Nike* system; $95,000 for supplies and services relating to the *Honest John* missile.

Telecomputing Corp. received $38,147 for warhead testers.

Hallamore Electronics, a div. of the Siegler Corp. received $43,066 for microlock test receivers.

Aerophysics Development Corp. received $44,000 for study reports for drop test of *Jupiter* nose cone.

Aerojet-General Corp. received $114,727 for study and design for a new missile systems test facilities for solid propellants; $296,937 for installation of instrumentation and control system in ABMA test facility area.

University of California received $27,046 for studies of natural and induced radioactivities.

FOR THE NAVY'S VANGUARD

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. . . contracts

By U.S. Army Ordnance Missile Command, Redtsone Arsenal:

Packard Manufacturing Co. received $25,177 for jato units XM37 metal parts.

E. I. Du Pont De Nemours & Co. received $33,876 for hydrogen proxide.

Thiokol Chemical Corp. received $560,492 for continuation of research in the field of solid propellant rocketry.

By Purchasing and Contracting Officer, Engineer Research and Development Laboratories:

Perkin-Elmer Corp. received $29,507 for reflectance spectrophotometer.

Armour Research Foundation received $39,166 for research study on nitrogen generating processes.

Alco Products, Inc. received $70,952 for design study of twenty-five megawatt pressurized light water reactor system.

By Picatinny Arsenal:

Nuclear Products, Erco Div., ACF Industries Inc. received $37,114 for development and fabrication of warhead unit assembly dolly, XH-4104 for the *Jupiter* guided missile.

By U.S. Army engineer district, Philadelphia:

The Ferber Co. received $327,915 for construction of conversion to *Hercules* and site improvement at special AAA site.

By Engineer District, Pittsburgh:

C. F. Mayer & Co. received $291,727 for *Hercules* conversion and elevator improvements at launching area.

Monroe Tree Surgeons, Inc. received $28,270 for masking area clearing at special AAA site.

By U.S. Army Engineer District, Los Angeles, Corps of Engineers:

Price-McNemar Construction Co. received $97,000 for conversion to *Hercules* at special AAA site.

By Engineer District, Detroit, Corps of Engineers:

Roth, Wadkins & Wise, Inc. received $570,396 for construction of supporting tactical facilities at special AAA sites, including all related work necessary.

By Engineer District, Jacksonville, Corps of Engineers:

Biltmore Construction Co. received $206,855 for construction of rocket storage.

By Engineer District, New York, Corps of Engineers:

Hall Construction Co. Inc. received $1,407,747 for conversion, *Nike Ajax* to *Hercules*.

Nassau Construction Co., Inc. received $1,379,440 for conversion, *Nike Ajax* to *Hercules*.

By Corps of Engineers, Office of the District Engineers:

W. Harley Miller, Inc. received $116,634 for construction of storage base rocket and assembly addition at Andrews AFB.

Reid, Inc. received $258,976 for construction of guided missile support building at Fort Belvoir.

By Engineer Division, New England Corps of Engineers:

Blount Brothers Construction Co. received $8,560,445 for construction of missile facility FY-58.

J. R. Cianchette received $6,814,744 for construction of missile facility.

Conyers Construction Co., Inc. received $254,987 for construction of alterations and additions to *Nike* batteries.

John A. Volpe Construction Co., Inc. received $8,684,862 for construction of missile facility.

The Portland Co. received $54,416 for improvements of elevators at *Nike* batteries.

By District Engineer, U.S. Army Engineer District:

Allen M. Campbell Co. received $123,008 for special projects laboratory; $331,231 for missile assembly bldg.

. . . contracts

The Costanza Construction Co. received $570,694 for special AAA conversion for *Nike-Hercules* sites.

Gowdy & Durkin, Inc. received $189,600 for construction of nitrogen distribution system, Part III, and carbon dioxide system for the supersonic circuit of the propulsion wind tunnel, Arnold Engineering Development Center.

Pearce and Gresham Co. received $326,773 for construction of misc. ABMA projects at Redstone Arsenal.

R. D. Lowman, General Contractor, Inc. received $1,149,411 for guided missile training facilities.

Hugh McMillan, Inc. received $260,722 for guided missile training facilities.

C. L. Castor Construction Co., Inc. received $479,019 for guided missile training facilities.

By Signal Supply Agency:

Polytechnic Institute of Brooklyn received $32,190 for research work on "thin-film of ferrimagnetic oxides."

American Electronic Labs, Inc. received $48,045 for research work on wide band, wide open spectrum analyzer.

Princeton University received $132,000 for research work leading to the determination of the relationship between the fundamental structure and the physical, electrical, mechanical and chemical properties of high polymers.

General Ceramics Corp. received $94,502 for research to conduct research investigation toward development of high frequency core materials by the synthesis of **ferrites.**

Polytechnic Institute of Brooklyn received $45,410 for research work towards the investigation of chemical bond type by measurement of electron distribution.

Radio Corp. of America received $125,820 for research to conduct a study and investigation for the purpose of developing transistorized radio relay systems.

Radio Corp. of America received $394,727 for study and investigation of a radio frequency rec. group.

Belock Instrument Corp. received $366,284 for antenna control equipments.

General Electric Co. received $87,676 for additional research study on development of electrical output recording storage tube.

Eastman Kodak Co. received $46,831 for research and development work continuing the investigation directed toward demonstrating feasibility of AVA batteries.

Radio Corp. of America received $90,000 for studies and surveys in the field of electronic component parts and materials.

American Electronic Labs., Inc. received $25,085 for untuned broad band crystal modulator covering frequency range from 50 mc to 12,000 mc.

Polytechnic Institute of Brooklyn received $60,000 for additional research and development to study theoretical investigation of transmission line formulation of semi-conductors.

Massachusetts Institute of Technology received $900,000 for research work on basic and applied research in the fields of electronic physics, molecular physics.

University of Pa. received $41,280 for research and experimental work in connection with "the effect of structure on the properties of stable organic free radicals."

Syracuse University Research Corp. received $275,600 for research work to conduct a study and experimental investigation of radar sensors and associated devices.

Gilfillan Bros., Inc. received $182,678 for installation kits for radar set.

By Springfield Ordnance District:

Roth Laboratory for Physical Research received $41,827 for research and development of ultrasonic methods of inspection.

By Engineer District Mobile, Corps of Engineers:

Maurice H. Connell & Associates, Inc. received $42,600 for architect-engineer services in connection with static test facilities at Redstone Arsenal.

AIR FORCE

By Ogden Air Materiel Area:

Boeing Airplane Co., Pilotless Aircraft Div., received $191,935 for technical data for IM-99 missile components.

By Wright Air Development Center:

Fairchild Guided Missiles Division, Fairchild Engine and Airplane Corp., received $300,000 for financing the preliminary development phase of a new airborne avionics system.

By San Antonio R&D Procurement Office, Wright Air Development Center, Air Research and Development Command:

American Institute for Research received $34,061 for improving adjustment of personnel assigned to isolated sites and development of indoctrinated procedures.

Miami Heart Institute, Inc. received $26,534 for additional research and delivery of research reports on plasmapheresis methods research project.

Southwest Research Institute received $28,817 for research and reports on radiation induced free radicals in chemical and biological systems.

By AFFTC, ARDC, Edwards AFB:

Electronic Engineering Co., of Calif. received $35,000 for installation of central data processing station.

Stanley Aviation Corp. received $99,468 for development of water brake and test vehicle.

Mine Safety Appliances Co. received $47,605 for development of an atmospheric monitoring system.

By HQ, 3610th Navigator Training Wing:

Convair Div. of General Dynamics Corp. received $1,718,645 for *Terrier* guided missile shipping containers.

By HQ, AFMTC, ARDC:

General Dynamics Corp. received $186,650 for design and fabrication of reference wave guide system and other spare parts for *Azusa Mark* I.

Dynatronics, Inc. rceived $75,835 for elevated balloon telemetry antenna system.

Milgo Electronic Corp. received $20,669 for modification kits for model 111 firing sequencers.

Convair-Astronautics received $585,152 for increase in equipment.

Milgo Electronics Corp. received $59,411 for increase in funds.

General Dynamics Corp., Convair Division, received $32,059 for increase in funds.

Westinghouse Electric Corp. received $188,000 for increase in funds.

LAST MINUTE AWARDS:

Avco's Crosley Division received a contract of $5-million for defense orders and supplemental funding for an existing contract, all related to ground radar . . .

Crosley also received $8,500,000 worth of defense contracts involving a major component for *Polaris* . . .

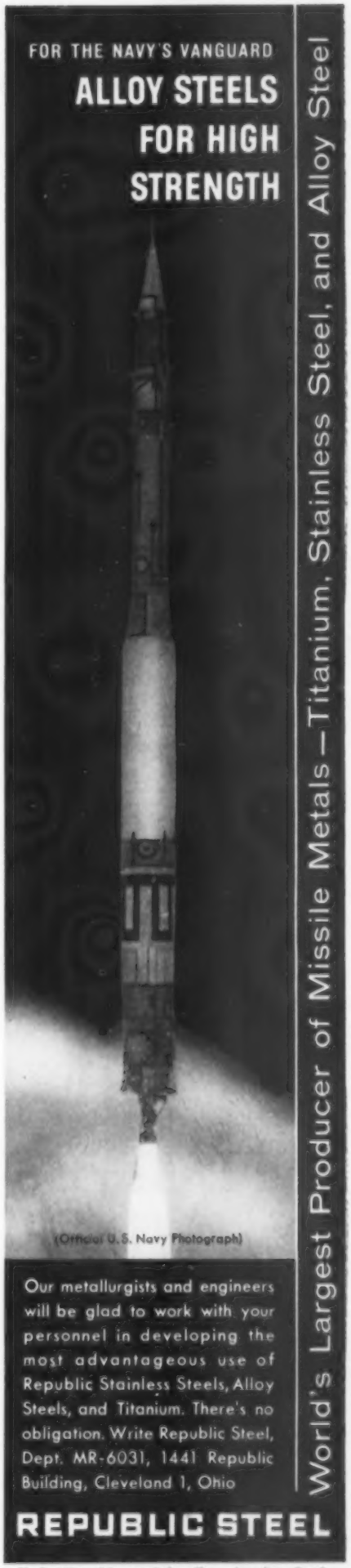
Boeing Airplane Co. gave to Fischbach & Moore, Inc. and Tellepesen Construction Co. $3,500,000 for installing mechanical and electronic support equipment in first tactical *Bomarc* missile base . . .

Norden-Laboratories Division of Norden-Ketay Corp. gave to Ryan Aeronautical Co. approx. $1-million for production line of company's ground velocity systems . . .

Army gave to Siegler Corp. $500,000 for constructing three tracking stations for the *Explorer* satellite . . .

Air Force gave two contracts totaling $807,757 to Motorola Western Military Electronics Center for design and fabrication of prototype C-band missile radar beacons . . .

Navy gave two contracts totaling $1,268,889 to Telecomputing Corp. for advanced electronics equipment . . .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Sputnik Rocket Fell in Mongolia

Contrary to Soviet claims that some remnants of *Sputnik* I's rocket fell on U.S. soil in Alaska and in the Northwest, and that we failed to cooperate with the Soviets by not delivering these unburned remnants, the final verdict of American scientists is that "the probable point of impact" of the first Soviet satellite rocket as it fell and burned was "at latitude 45° N. and longitude 106° E. in Outer Mongolia."

This finding, based on a series of careful observations and reports, is presented in a brief paper entitled "Fall of the *Sputnik* I Rocket" by R. Jastrow and I. Harris of the Nucleonics Division of the U.S. Naval Research Laboratory.

They state that their "analysis is based on several observations of the altitude of the satellite during the last five days of its lifetime. Our calculations lead us to the conclusion that 1957 Alpha 1 fell on December 1 at 0846 GMT, approximately eight hours after the last radar observation made on it in the U.S."

On December 8, one week after the fall of the Soviet carrier rocket, Alexander N. Nesmeyanov, president of the Soviet Academy of Sciences, sent an inquiry to Detlev Bronk, president of the National Academy of Sciences, on the subject of the fallen rocket. A similar cable was sent December 9 by Academician Ivan P. Bardin, president of the Soviet IGY Committee, to Dr. Joseph Kaplan, chairman of the U.S. National Committee for the IGY.

In reply, Dr. Bronk assured Dr. Nesmeyanov that "our review thus far of sightings and trackings of satellite, and investigation or reports of objects sighted, do not indicate rocket or remnants fell in the U.S. or its territory." Now, the Jastrow-Harris report gives the final answer to the Soviet inquiry, proving beyond doubt that the rocket's remnants fell in Red territory, not ours.

Fixed Spending Ceilings For DOD Reconsidered

The Senate Appropriations Committee has cleared the way for reconsideration of legislation that would authorize the President to propose, and Congress to concur in, fixed annual spending ceilings for the Defense Department and other government agencies.

The Senate has already approved an amended version of HR 8002, simultaneously rejecting a move by Chairman Carl Hayden (D-Ariz.) to limit the legislation to the Department of Defense. Amendments to the bill were accepted on a roll call vote.

Although the spending-ceiling legislation was opposed by large segments of industry, most spokesmen preferred HR 8002, which does not basically alter the present method of appropriating money, as would the Senate-passed bill, S434, a much sterner measure.

The Senate bill, would authorize the President to fix a proposed annual spending ceiling when he submits an agency's budget. He would have to determine if the agency has an accounting system capable of handling the accrued account. House and Senate Appropriations Committee may then fix the limit to be spent in that particular fiscal year.

Backers of the bill anticipated no difficulty in getting Senate passage of the bill, since the tougher S 434 Kennedy bill sailed through unopposed last year. Defense and aircraft industry spokesmen filed their views on the bill, most of whom opposed it. Donald Douglas, Jr., president of Douglas Aircraft, said he is firmly convinced "this type of legislation will not bring fiscal improvements."

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Soviet Affairs

by Dr. Albert Parry

The Soviets certainly have their equivalent of our *Nike*, but they are not advertising it. A striking example of this reticence is the recent issue of KRASNAYA ZVEZDA (The Red Star), the chief daily newspaper of the Ministry of Defense of the USSR.

Devoted almost entirely to the troops of Baku on the Caspian shore, a foremost Red oil center in the Caucasus and an otherwise strategic point of prime importance, the issue stresses the Soviet commands concern over that area's defense, yet says not a word about any missile installations around Baku.

Colonel General V. Ivanov, commander of the Baku military district, writes about the rocket-launching sites being built by the U.S. "on the territories of certain states, undoubtedly aimed against our Fatherland and other socialist countries."

He implies that American missiles are aimed against his military district of Baku, and among his own measures of defense he lists fighter-planes, anti-aircraft guns and other services—all except ground-to-air missile installations.

The front page of this particular issue of KRASNAYA ZVEZDA features a Soviet artist's pen-and-ink drawing, detailed and large, representing Baku and its defenses. Prominent in the drawing are Red fighter-planes in flight and poised anti-aircraft guns, but missile batteries are completely absent. In his article, General Ivanov reveals that Baku's massive anti-aircraft batteries, while training, score two hits out of every five salvoes. According to the general, this is a respectable record, but, if any missile batteries are interlarded with such conventional guns, their records are not indicated.

The Red side also continues to deny the existence of any Soviet rocket-launching sites on the soil of the so-called "people's democracies" west of Russia's borders. Yet, reports a traveler recently returned from Poland, the presence of a large Soviet military mission in Warsaw is commonly explained by Poles in these words: "The Russians are building rocket bases."

The traveler adds the paradoxical observation that, hating the Russians as the Poles do, the Poles nevertheless welcome Russian rocket bases on their soil. For the Poles hate the Germans even more than they hate the Russians.

In their view, the Soviet rocket bases will defend Poland in case of attack.

Everywhere in the Soviet dominated belt of Eastern and Southern Europe, Communist governments keep on declaring that they have no rocket bases on their soil, but that they would install them should Western powers build such bases in Western and Central Europe. The latest "satellite" to make this announcement is Albania.

Should Italy allow the U.S. to install its rocket bases on Italian soil, this would constitute a breach of the Italian-Albanian peace treaty, and the Red government of Albania would then erect rocket bases on its territory. Such is the warning issued by the Communist government at Tirana in a formal note to the Rome government—on orders from Moscow, of course.

From the moment of its initial orbiting on May 15 and up to July 1, *Sputnik* III covered "more than one half of the distance between the Earth and Mars, when they are farthest apart." So stated Professor B. V. Kukarkin, vice-president of the Astronomical Council of the Soviet Academy of Sciences. He also related that *Sputnik* III became first visible from Soviet territory on June 13, or nearly one month after its launching.

From June 13 to June 30, inclusive, Soviet watchers noted 147 passings of the carrier rocket and 90 passings of *Sputnik* III itself. Best observations were made by astronomers and lay-watchers in Moscow, Smolensk, Chernovtsy, Kharkov, and (in Eastern Siberia) at Komsomolsk-on-Amur and Blagoveshchensk. In all, 80 stations in the USSR and nearly 30 stations outside the USSR participated in the observations and reports on *Sputnik* III.

Visual observations showed that both *Sputnik* III and its carrier rocket changed their brightness considerably while in flight. At its most brilliant, the rocket was brighter than any star and could be likened only to Jupiter. At such moments *Sputnik* III was as visible as a star of the Great Bear (Ursa Major).

"We are on the eve of solving the mystery of the Tungus Meteorite," V. Lutsky, a lecturer at the Moscow Planetarium, announced in IZVESTIA. This summer, a new expedition of the Soviet Academy of Sciences is working in East Siberia, investigating the puzzle of the famous Tungus Meteorite which struck the area of the Podkamennaya Tunguska River 50 years ago, laying waste a huge expanse of forest but leaving hardly any vestiges of its own body. The findings of the current expedition are awaited with interest.

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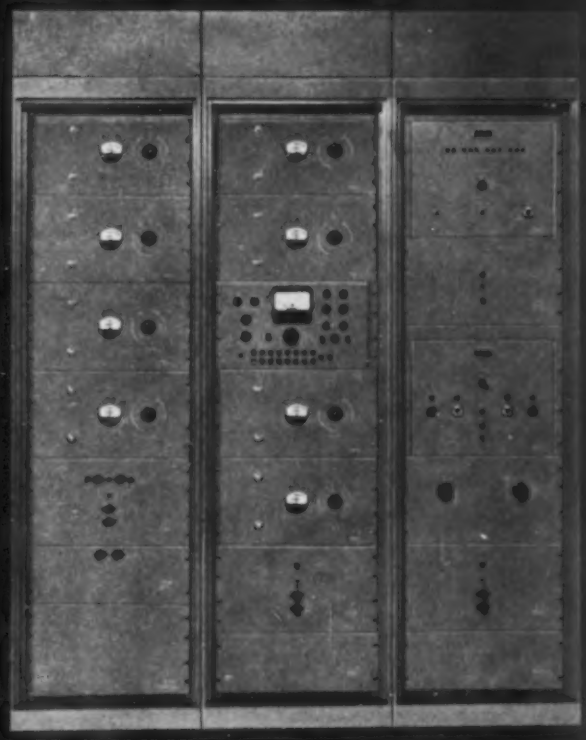

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Moscow briefs

• **A Soviet general** declares that "apparently the mastery of the process of guided thermonuclear reaction will bring us closest to the solution of the problem of the most economical (as regards weight) source of energy" for future space flights.

Maj. Gen. T. M. Melkumov, writing in VESTNIK VOZDUSHNOGO FLOTA, the monthly journal of the Soviet Air Force, is a doctor of the technical sciences and a professor of astronautics.

He also mentions the suggestion that trajectories of future interplanetary flights should be studied with special attention to the problem of "a minimum expenditure of energy for such flights."

He discusses the orbit of Mars, and dwells on the problem of changing successfully from the Earth's orbit to the orbit of Mars. He said this is a most vital point in establishing the flight's trajectory to Mars, particularly as pertaining to a minimum energy expenditure for such a space flight.

• **Level lunar areas** possibly exist, declares Prof. N. Barabashov, the well-known Soviet astrophysicist and chairman of the Planetary Committee of the Astronomic Council of the Soviet Academy of Sciences.

The latest study of the moon's surface by Soviet savants demonstrates that a considerable part of the lunar landscape is covered with a layer of vulcanic ashes and the products of the melting of the moon's ores. This is the result of the meteorite "showers" so frequently falling on the moon. As they fall, the meteorites become red-hot and melt, simultaneously causing the outer layer of the ores to melt.

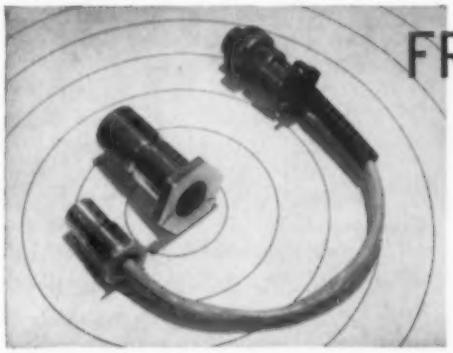
Certain parts of the moon's surface are apparently covered with large lumps of ores split open under the impact of the sharp changes in the moon's temperatures, from 120 Celsius degrees of heat in daytime to 200 Celsius degrees of cold at night.

Prof. Barabashov's statement was made in connection with a special session on the physical conditions of the moon and other celestial bodies, held recently in the Soviet Ukraine by the Academy's Astronomic Council. Astronomers, astrophysicists, and astrobotanists from all over the Soviet Union were in attendance.

• **"Sputniks and Chemistry,"** an article in SOVETSKAYA AVIATSIA, quotes Prof. I. P. Losev as saying that the latest Soviet chemical research played an important role in the successful launching of the three *Sputniks*.

Prof. Losev, who is doctor of the

do you have these missile power problems?



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chemical sciences and president of the Mendeleyev Chemical Society, declares that the *Sputniks* are well guarded from meteorite blows due to "Soviet-made plastics which are as strong as military tank armor, yet weigh lighter than wood."

He adds that the rocket carrying *Sputnik* III also owed its triumph to Soviet chemistry. "The rocket's heart—the engine—works at temperatures that can be endured only by special heat-resisting alloys and metal-ceramics. These alloys have been evolved by our science of chemistry."

Dr. Losev concludes by praising Russian chemists for the rocket's fuel, "which requires special care, and which, too, has been produced by the toil of our chemists."

• **From Sputniks to space flight:** "Our *Sputniks* prove the feasibility of interplanetary journeys," declared Prof. V. Fedynsky at a Moscow meeting of the Society for Dissemination of Political and Scientific Knowledge. Moscow TRUD reports that the professor's speech "was met with great interest."

• **"In Sputnik III,** a man can find enough place for himself, but it is still too early to speak of launching a *Sputnik* with a man in it," says Academician Leonid Sedov.

He points out that the main difficulty of sending a man up in a *Sputnik* is not in the "danger of biological character," but in the problem of re-entry. In the same statement, Sedov predicts that flight to Mars will become an actuality "within the next 20 years."

• **"Why must one fly into Cosmos?"** This is a headline in KOMSOMOLSKAYA PRAVDA, citing a letter from a Soviet reader who does not understand why all the fuss is made about the conquest of outer space.

"What is the pressing need for all those expenditures of money and materials and perhaps even of human lives for the sake of such conquests?" he asks. He goes on to say that he can understand the self-sacrificing heroism of physicians who experiment new vaccines on themselves; also the military courage of Soviet officers and soldiers; but "the meaning of conquering interplanetary space is incomprehensible to me."

The editor of KOMSOMOLSKAYA PRAVDA was shocked. He asked Prof. V. Dobronravov, an outstanding Soviet astrophysicist, to explain the reasons for man's wish to conquer outer space. The scientist answered in a lengthy article citing a number of valid reasons.

• **To encourage and satisfy the** popular Soviet interest in *Sputniks* and planets, ten "people's observatories" are being planned and built by Moscow municipal and regional authorities in parks and other public places.

Four of these observatories will be opened in July, and the rest will be opened later. Each observatory, built of brick in a cylindrical form, will be one-and-a-half stories high. Telescopes, available for amateur's use, have already been received from East Germany, where they were manufactured especially for this purpose. Not only observation, but also the photography of planets, will be available to the amateur Muscovite.

• **Nearly 900 non-Soviet astronomers** are expected in Moscow at the 10th International Astronomic Congress in August. Two symposiums are scheduled; one on the problem of the Earth's rotation, the other on the spectral problem and the question of evolution of stars.

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Results of the study of the sun's flares; the problem of the formation of chemical elements in stars; and astronomic observations with the aid of satellites, balloons, and rockets will also be discussed.

• **"Today solar batteries** on *Sputnik* III work together with silver-zinc accumulators," writes D. Bilenkin in KOMSOMOLSKAYA PRAVDA. "But on some future *Sputnik* solar batteries will be the only source."

• **Col. B. Aleksandrov writes** in his article "The Military Air Force of the U.S. in Europe", published in SOVETSKAYA AVIATSIA: "Striving to achieve a maximum strengthening of air grouping in Europe, the U.S. military authorities have moved three groups of TM-61 *Matador* guided plane-missiles into W. Germany. The launching sites of these plane-missiles, which have a range of nearly 1,000 kilometers, are placed in immediate proximity to the frontiers of socialist countries."

• **In order not to "upset" West German** public opinion, the Bonn government has sent the "guided rocket *Matador*" to the deserts of Libya in North Africa, instead of shipping them from the U.S. to W. Germany.

German soldiers will be trained to handle the *Matador* on North African sands. This "revelation" is made in the Moscow IZVESTIA, which in a special article, protests against the American, W. German, and French action in "turning Africa into an atomic and rocket launching site."

The Soviet newspaper charges that the Bonn government caused the *Matadors* to be sent to North Africa instead of W. Germany "on advice from Washington."

• **A large model of Sputnik III,** exhibited in the pavilion of the Academy of Sciences at the Industrial Exposition in Moscow, has attracted general attention.

• **In the anti-religious campaign** currently being stepped-up by the Soviet government, the Communist party's official organ PARTIYNAYA ZHIZN recommends to its propagandists of atheism that they use the successful launching of the three *Sputniks* as proof enough that "there is no God."

• **Mystic believers** in Western Europe have already chosen a special patron saint for interplanetary trips of the future.

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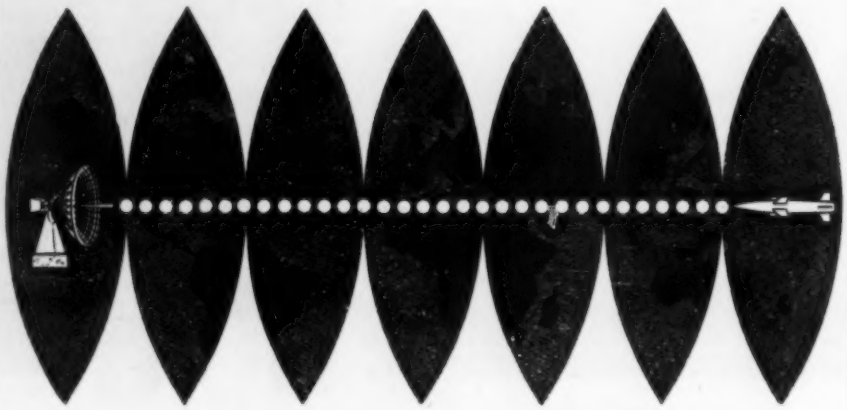

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. . . Moscow briefs

in KOMSOMOLSKAYA PRAVDA, the saint is "Joseph Cupertino, canonized in 1767. He was a Franciscan monk who was reputed to possess the miraculous faculty of flying from the church doors to the altar and back."

• **Nearly 400 projects** of an obelisk to commemorate *Sputnik* I have been submitted in the contest sponsored by the Soviet government. Cash prizes are given for the best presentations. Not only sculptors, but engineers and architects are among the contestants.

More than 360 of the submitted models are now being shown in the Central Exhibition Hall in Moscow. The winning monument will be erected in the Lenin Hills of Moscow, near the skyscraper building of the University of Moscow.

• **A monument to Konstantin Tsiolkovsky,** the Soviet rocket pioneer, was recently unveiled in Kaluga, central Russia—for many years the residence and research site of the famous Russian astrophysicist.

A silvery rocket model, 19 meters high, is the background for Tsiolkovsky's bronze figure. The granite pedestal bears the inscription, "K. E. Tsiolkovsky. 1857-1935," and the following quotation from his writings:

"Mankind will not remain on Earth forever, but in its quest of light and space will at first timidly penetrate beyond the confines of the atmosphere, and later will conquer for itself all of the space near the sun."

• **The recent decrease** in the output of higher degrees of Soviet learning alarms the Moscow ministry of higher education.

The Ministry published figures which show that, whereas in 1955 some 11,800 diplomas of the candidate of sciences were issued in the Soviet Union; in 1956 only 7,800 such diplomas were earned; and in 1957 the number was catastrophically low—a mere 3,500.

Of the 240,000 Soviet scientists, one-half are on the teaching staffs of Russia's universities and institutes. Of this one-half, only a mere 43% have their learned degrees of doctors and candidates of the sciences—an inexcusably small ratio in the opinion of Soviet leaders.

• **U.S. devices of "long-range radars"** are described in a recent issue of KRASNAYA ZVEZDA (The Red Star), the central organ of the Soviet armed forces, on the basis of material appearing in m/r. Our magazine is quoted

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in the Moscow publication explicitly by name. An illustration, accompanying the Soviet article, is taken from our pages.

• **"We are not inclined to deprecate** the scientific genius of the American people," G. Rassadin writes in SOVETSKAYA AVIATSIA. "It isn't such a misfortune for them that they lag in satellite launching." But, the Moscow writer goes on, those "aggressors" in the Pentagon shouldn't try to create weapons aimed at the shooting down of Russia's *Sputniks*.

Nor should the Pentagon dream about "the establishment of American military bases on the Moon," which, as everyone knows, is "a peaceful and lyrical celestial body." Comrade Rassadin also recommends that "the liquidation of American military bases on other peoples' territories of the Earth" should have been the best and "most realistic reaction to the orbiting of *Sputnik* III."

• **"A space ship at any time,"** announce two Soviet scientists of aeronautics and astronautics in IZVESTIA. The pair are A. Ilyushin and V. Lensky, who declare that the new Soviet rocket designs and fuels will soon allow Russia to launch cosmic ships.

They write: "Our rocketry is capable at any time of overcoming the second cosmic barrier by adding to the speed of the original rocket, which was 18,000 miles an hour, one more stage which would produce a speed of over 25,000 miles an hour."

• **Rockets haven't displaced** conventional aircraft as a weapon. So writes Colonel A. Lapenin in SOVETSKAYA AVIATSIA, stating: "The logical process of the qualitative development of modern means of the air attack, particularly of ICBMs and IRBMs, does not at all mean that aviation has outlived its usefulness, and that in the very near future it will be completely replaced by rockets."

He points out that the arming of jet planes, both bombers and fighters, with air-to-ground and air-to-air missiles, also with atomic- and hydrogen-warhead bombs, only strengthens the role of military aviation rather than displace it. "Piloted planes will be needed in modern war," Col. Lapenin maintains, for in certain tasks in the warfare of today and tomorrow "reason-directed actions of a pilot" will be necessary.

• **A special military planetarium** has recently been opened in Moscow, introducing Soviet officers and soldiers to the space age. The planetarium is established at the Frunze Central House of the Soviet Army, with the aid of telescopes and other equipment.

Titles of lectures delivered to Red troop detachments brought to the planetarium are: "Flights into Outer Space," "About the *Sputniks*," "The Modern Concept of the Universe," and "What is Happening on the Sun?" A tower for visual observation of satellites is being erected next to the planetarium.

• **Soviet writers can imagine** future flights to Venus with an abundance of detail on the construction and performance of the Red interplanetary ship making the flight. They can visualize "cosmic landscapes" en-route to and from Venus. They can graphically describe the climate, flora, and fauna of Venus.

But they cannot create stories of the lives—of the day-to-day doings and characteristics—of the Communist astronauts of the future. There is hardly a detail in the writings of present-day Soviet science-fictioneers pertaining to the structure of the interplanetary Communist society of the future. Such is the latest charge advanced by the Moscow government against its own

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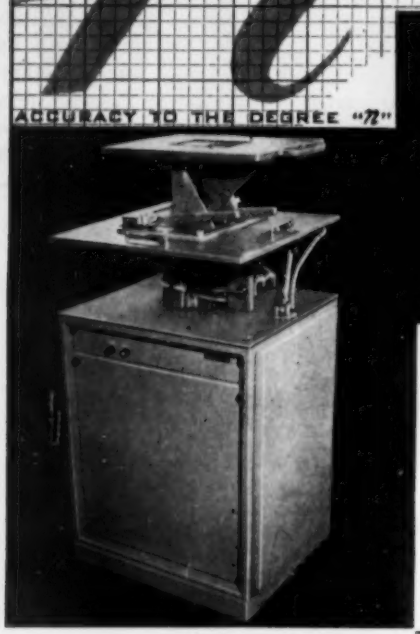

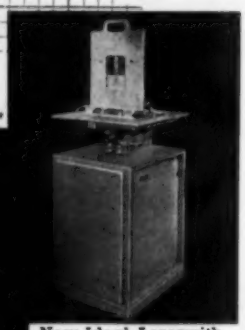

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. . . Moscow briefs

science-fiction writers.

The complaint was voiced by Khrushchev's officials at the All-Russian Conference on Adventure and Fantastic Scientific Literature. No hint of Communism can be found in tales written by science writers, laments Vladimir Dmitrievsky in IZVESTIA.

"Apparently, the time of action is Communism," he notes about the modern Soviet tales of the future. "For only a Communist society, finally uniting all mankind, will be capable of achieving those things of which these writers tell us. Well, then, do tell us about the future of our Earth, friends, do tell us about Communism! . . . Otherwise, the writer of fantasy will not be able to crawl out of his shell of scientific and technical hypotheses, will not fling apart the doors of the future before the reader."

Could it be that Soviet writers cannot and will not write of this interplanetary Communism of the future because they believe in interplanetary flights, but do not believe in Communism? A heretical thought, comrades, but most likely a true one nevertheless.

• **How strong is the Soviet Academy?** The latest statistics of the Soviet Academy of Sciences, released by the Moscow government, show that the top body of Russian learning has a network of 75 major scientific-research Institutes, not counting a tremendous number of lesser Institutes within the Academy's 12 "filials."

In addition to the central Academy in Moscow, provincial capitals of the Soviet Union have 13 Academies of Sciences of their own. There are also many special, separate Academies for various industries. The central Academy in Moscow has 167 full-fledged academicians and 361 corresponding members (a lesser category).

• **"To predict today the future of astronautics** is a dangerous thing," Professor Anatoly Blagonravov said to the young people of the Soviet Union on the occasion of the recent Youth Day in his country. "The pace of space conquest is so fast, that, tomorrow, the boldest prognosis may become a mere commentary on the events of yesterday."

Still, the Soviet astrophysicist was "certain that some of you will have the luck of walking on the edges of lunar craters with hammers of geological exploration in your hands; and of compiling the map of the continents of Venus; also of describing the flora and fauna of Mars."

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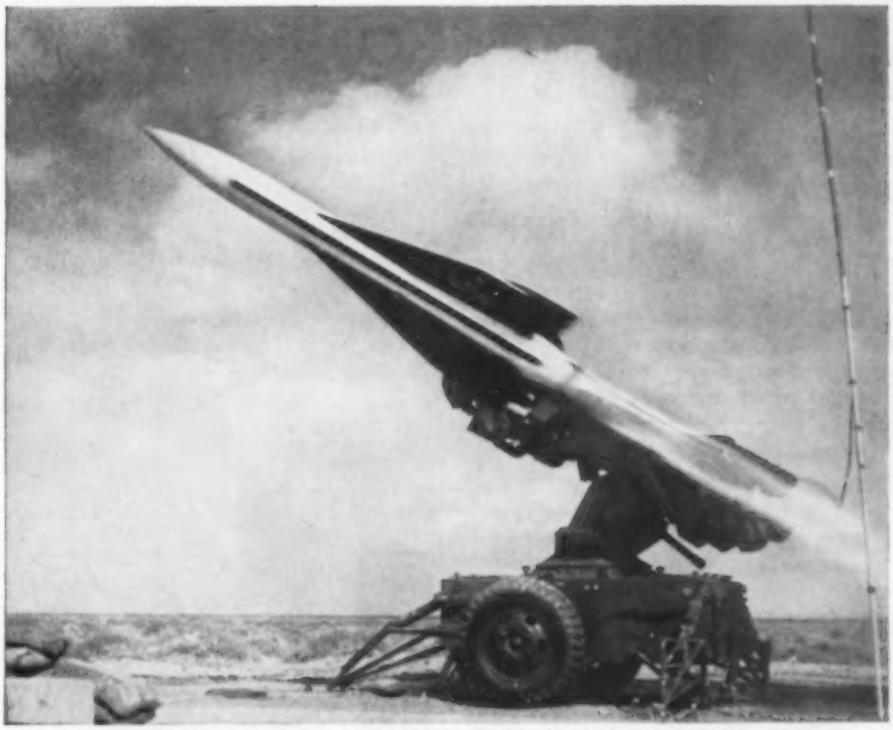

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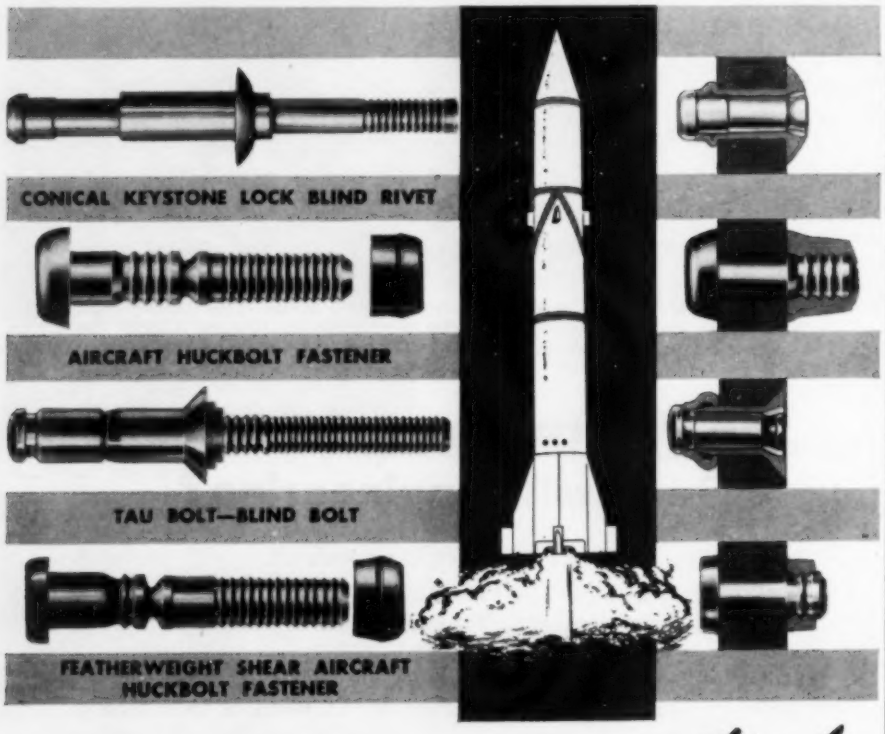
Sidereal Rate Turntable Measures Gyroscopic Drift

A sidereal rate test turntable to measure error or drift of gyroscopic and inertial equipment is available from J. W. Fecter Inc., subsidiary of American Optical Co.

The unit, claimed by the company to be "the most accurate in production today," is a positively driven, equatorially mounted platform which rotates at exact pre-set rates equal to the earth's rotation or at multiples of the earth's rate in either direction. With the effect of the earth's rotation effectively nullified, the equipmnt under test is isolated in inertial space. Its performance under known drift rates can be evaluated. With a 360 degree rotational cycle, position to an accuracy of plus or minus 3 seconds of arc is maintained.

The drive system is housed in the table's pedestal and incorporates a hysteresis synchronous motor couple with precision reduction gears.

Circle No. 248 on Subscriber Service Card.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AIRCRAFT HUCKBOLT FASTENER
TAU BOLT—BLIND BOLT
FEATHERWEIGHT SHEAR AIRCRAFT HUCKBOLT FASTENER

ENGINEERED FOR *out-of-this-world* PERFORMANCE !

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Huck produces a complete line of aircraft fasteners in aluminum or steel for blind or two side application. There is a style to meet any aircraft requirement . . . high shear or tensile strength, sealing, hole filling, pull together or vibration proof . . . available in flush or protruding heads and with positive mechanical lock.

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Circle No. 90 on Subscriber Service Card.

Overload Clutches Protect Against Damage

Mechanical overload clutches designed to protect assembly machinery against damage have been brought out in a new line of "Safe Torque" clutches by Scully-Jones and Co., Chicago.

Two standard ratings of precise torque control clutches are currently available: to 84 in. lb., and 48 to 120 in. lb. Other models have been developed up to 800 lb. ft.

Two general lines of clutches are included in the Scully-Jones line: a one-shot type and a continuous overriding type. Torque setting of the clutches can be sealed against unauthorized tampering, if desired. One-shot clutches may be re-engaged in several ways—by reversing the rotation of the drive shaft, by axial movement, or other means. Continuous overriding clutches are used on slow-running applications such as hand-tightening of fasteners.

Circle No. 249 on Subscriber Service Card.

Shaft-Angle Encoder Has Built-in Alignment

A new Dychroverter which can meet the structural and operational requirements of 13-digit shaft-angle encoding contains a built-in alignment cell for establishing optical-mechanical concentricity precise to 110 parts per million.

Designed and built by Dychro Corp., accuracy of shaft-angle indication can be held to better than xx ±2.5 minutes of arc. At 366 rpm, the probability of a 1-bit error, representing only a ±1.3 minute maximum angular error, is 0.75. Readout is possible up to a maximum reading rate of one hundred complete digital words per second. Dychroverter can encode the angular position of high-speed rotating shafts without use of brushes or moving contacts.

The instruments are useful as the feedback element in digital shaft positioning servomechanisms, to couple rotating analog devices into digital computers and for converting two-speed analog shaft data into a single, linear, digital word for data processing.

Circle No. 250 on Subscriber Service Card.

Practical Inductance Limits Available

Magnetics Inc. has introduced guaranteed practical inductance limits for regular and temperature stabilized permalloy powder cores.

According to the company, the temperature-stabilized permalloy powder

cores, which produce frequency stability, eliminate difficult compensation problems.

The new inductance limits are guaranteed for all permalloy cores, whether stabilized or not, and are available in 7 sizes. The "D" range powder cores have a total inductance change of less than .2% between 30°F and 130°F.

Circle No. 251 on Subscriber Service Card.

Atlanta, Inc. Offers New Range Towers

A new series of model range towers for supporting and positioning antennas, reflectors and scale model airframes is available from Atlanta, Inc.

Built entirely of low dielectric constant materials above the base unit, reflectivity or radiation pattern measurements can be made under simulated free space conditions.

The company listed other features as variable speed drive and dual synchro position information for both axes, optional height of 8 and 16 feet by use of an 8-foot extension section and a load capacity of 200 pounds.

Circle No. 252 on Subscriber Service Card.

Servo Motor Gear Heads Have Close Tolerances

A new line of servo motor gear heads, said to be adaptable to any make of motor, has been announced by the Instrument Division of Thomas A. Edison Industries.

The announcement said that the heads are available in any ratio between 1%, and that the gears have a backlash of only 30 min. maximum, measured at the output shaft with maximum running torque applied as a reversing load. Closer tolerances are said to be possible, on special order.

The great precision is said to be a result of spacing gear clusters between separate gear plates, and the use of bronze gears and stainless steel pinions splined to their shafts for added strength.

Circle No. 241 on Subscriber Service Card.

Bobbinless Resistors For Missile Applications

Packaged in two case styles—R-2 and R-5—a line of bobbinless precision wire-wound resistors is now available from General Transistor Co. of Jamaica, New York City.

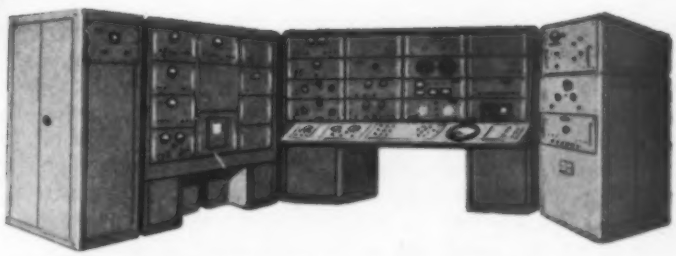
The units are claimed to be ideally suited for printed circuit boards, and subminiature assemblies for airborne and missile applications.

According to the company, principal

THE AN MPS-26 RADAR (C-BAND)
SEARCH ACQUISITION AND PRECISION
TRACKING RADAR SYSTEM . . . . . by CANOGA
NOW TO BE USED FOR
MISSILE RANGE INSTRUMENTATION
BY THE NAVY, BUREAU OF AERONAUTICS

THE STANDARD for RELIABILITY

MOBILE



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High power capability for extreme range performance.

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. . . CEC's 5-122 Recording Oscillograph

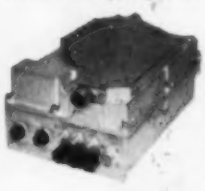
permanently records 26 channels of data simultaneously (plus 2 reference traces) on film or paper

CEC'S 5-122 IS BUILT TO TAKE IT—to surpass the endurance of ordinary instrumentation. Compare this combination of environmental *operating* specifications with any oscillograph made: Temperature range from −65° to +250°F at altitudes to 120,000 feet . . . Will withstand a steady acceleration of 15 G's along any of its three major axes without interruption or deterioration of its performance . . . Operates in salt-sea and dust-laden atmospheres and in a relative humidity up to 100% at +122°F. . . Explosion-proof certification . . . Built-in vibration isolators provide firm protective support and eliminate the need for external shockmounts.

CRASH-RESISTANT MAGAZINE. The all-important record of test results is always secure in the 5-122's record magazine. This crash-resistant unit is engineered to withstand the same abuses as the oscillograph plus a shock of 200 G's for 4½ milliseconds.

NOTHING SACRIFICED FOR ENVIRONMENTAL SPECIFICATIONS – Standard features of the 5-122 include a writing speed of more than 12,000 ips . . . jump-speed selector . . . flash timing . . . 12 record speeds from 0.047 to 96 ips . . . automatic record identification . . . and provision for synchronous operation with an over-all data acquisition system. The 5-122 weighs only 80 lbs. fully loaded and is 11″ wide, 8″ high, 18½″ long.

For complete details, contact your nearest CEC sales and service office or write for Bulletin CEC 1585-X11.



MASTER TIMING UNIT supplies timing pulses to the 5-122. Can control up to 10 oscillographs and may be remotely located.

CONTROL UNIT contains all controls for operation of oscillograph. Is also ideal for remote operation.

HIGH-TEMPERATURE GALVANOMETERS – CEC High-Temperature Galvanometers guarantee high sensitivity and accuracy in ambient temperatures to 250°F for extended periods. Fluid and magnetically damped types cover frequencies from 0 to 3000 cps. Write for Bulletin CEC 1528-X17.

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features of the instruments include: welded case construction to insure hermetic seal; welded terminations to eliminate noise; bobbinless construction which eliminates strain and stress on wire under extreme environmental conditions.

Circle No. 242 on Subscriber Service Card.

Holding Fixture Designed For High-Speed Production

A dual-chucking, cylinder-operated holding fixture, said to be designed for use on high-output production operations, is now available from S-P Manufacturing Corp.

The fixture is designed to be used individually or in groups on a rotating work table, to provide simultaneous chucking of two identical parts. The fixture provides clamping jaws set at a 45 deg. angle so that both horizontal and vertical machining can be done without rechucking.

Circle No. 243 on Subscriber Servce Card.

Primary Battery Operates at —100° for Cold Work

Named the Yardley Arctic, a primary battery that is said to operate at –100°F has been developed by Yardney Electric Corp.

According to company announcements, the product is the first unit that can supply appreciable currents at temperatures below –65°F. The cell, which is non-aqueous, employs calcium for the negative plate, silver chloride for the positive plate, and an electrolyte with acetonitrile solvent. The unit is hermetically sealed and is expected to have an indefinite shelf life.

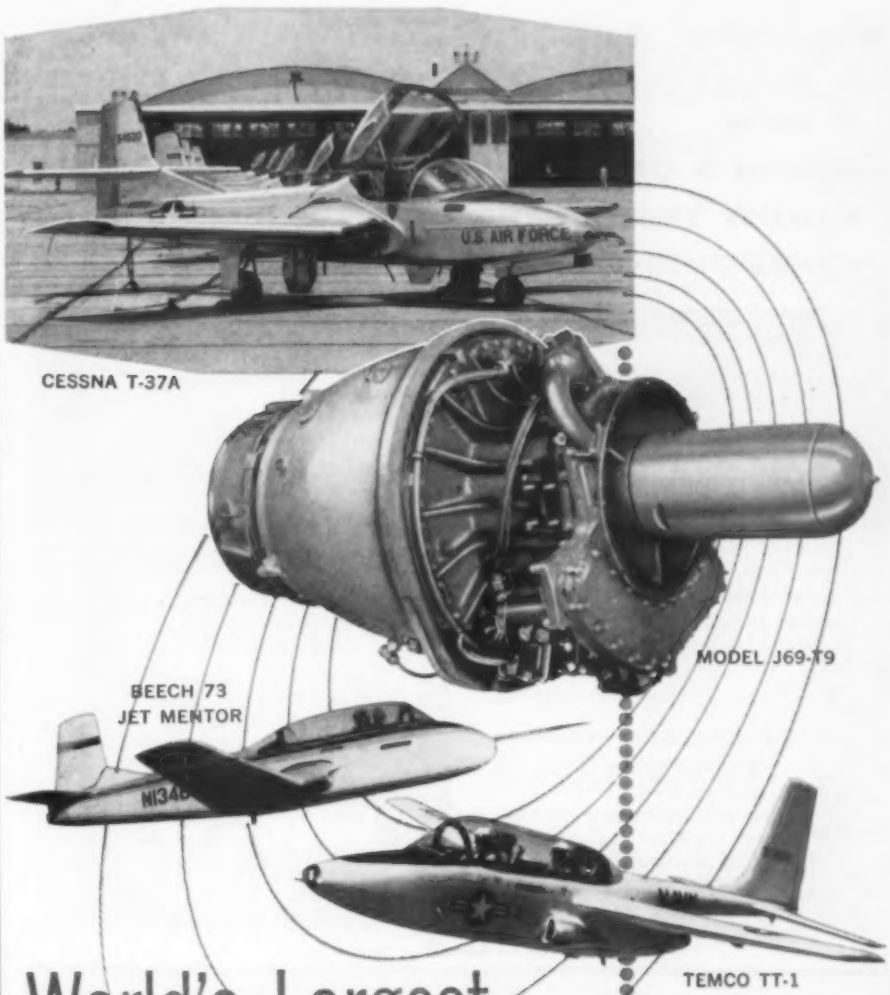
Circle No. 244 on Subscriber Service Card.

High-Performance Torquer for Stabilized Platforms

A new high-performance Torquer, Model ARTQ-1, has been developed by Aeroflex Corp. to actuate large stabilized platforms mounting heavy aerial cameras, infra-red devices and radar antennas.

The Company says that a new design and new manufacturing techniques allow fabrication at low cost, while at the same time reducing the weight and size of the torquer. It is also claimed that the design makes possible extremely smooth motion and eliminates radio noise, sparking, wear and explosion hazards.

The machine is said to be capable of high-altitude continuous performance in ambient temperatures of 130°



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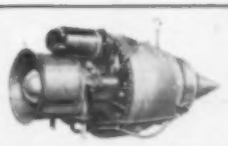
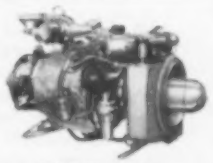
As the pioneer American builder of small gas turbines, Continental Aviation and Engineering Corporation occupies a unique position in this relatively new field of power. Not only is it the largest producer of engines of this type and size; it is also the most thoroughly qualified by experience, and the most completely equipped. Those having present or prospective need for gas turbine power—for applications on land, at sea, or in the air—are invited to lay their problems before C. A. E. engineers.


MODEL J69-T-19A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AIR COMPRESSOR

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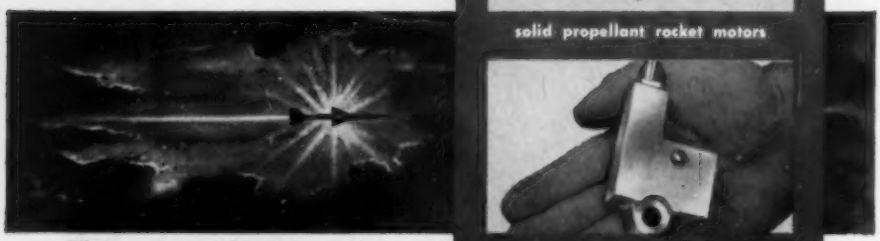

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centigrade, and develops torques up to 15-in. lb. at a torquer weight of 6 lb. for the camera application.

Circle No. 245 on Subscriber Service Card.

In-Line Flow Regulator Pressure Compensated

A new in-line pressure-compensated adjustable flow regulator is now available from Fluid Power Accessories.

Changes in flow rate are accomplished by rotation of the valve sleeve. According to the company's announcement, calibrations of the sleeve facilitate repeat flow settings without tedious adjustments. A built-in check valve provides for free flow in the non-compensated direction. The valves are available in one-quarter, three-eighths and one-half inch pipe sizes, for flow rates to 5, 10 and 18 gpm. Maximum operating pressure is 3,000 psi.

Circle No. 246 on Subscriber Service Card.

Low Voltage "Strings" For Precision Instruments

A new line of Zener reference "strings" designed specifically for an extremely low amount of voltage change over a wide temperature range has been introduced by the Semiconductor Division, Hoffman Electronics Corp., Evanston, Illinois.

The "strings" were designed for applications where voltage output and temperature coefficient requirements are not compatible with the performance of a single Zener diode, such as in the precision instrumentation field.

Typical applications include semi-precise regulator circuits, where temperature stability is of prime consideration and line or load changes are not wide or have been reduced by pre-regulation; as the input stage in precision circuitry employing lower temperature coefficient reference elements, and as the reference element for feedback power supplies where higher voltage than a single 1N429 is required from the system gain and bias considerations in the external circuitry.

Circle No. 247 on Subscriber Service Card.

Compact Electronic Timers Designed for Military Use

The A. W. Haydon Co. of Waterbury, Conn. manufacturers of standard and custom designed electrical and electro-mechanical timing devices, has announced a new line of Electronic Time Delay Relays.

Some of the main features which these timers will offer, that cannot readily be supplied in electro-mechanical

timing devices, will be high temperature operation, high vibration, light weight and very short time delays.

A transistorized R.C. time constant network is used to establish the time delay and eliminate all moving parts except the load switching relay. Designed primarily for military applications these compact units offer high reliability under extreme conditions of temperature, vibration and shock.

Two series are currently offered with time delays ranging from 50 milliseconds to 60 seconds. Operating voltage for either type will be 18 to 30 Volts D.C., although operation on A.C. voltages can be offered.

Circle No. 253 on Subscriber Service Card.

Ultra-High Temperature Absorber Available

Eccosorb HT, developed by Emerson and Cumings, Inc., is a series of broadband microwave absorbers which are useful from −70°F. to +1200°F. Because of high temperature capability, the absorber can be used where high power levels are involved. It finds particular application for lining metal housings used to cap radiating antennas. Exact power handling of Eccosorb HT is dependent upon the heat transfer situation. A typical value is 50 watts/square inch.

Eccosorb HT is supplied in the form of light weight unicellular foamed ceramic bricks. These bricks can be stacked on one another to produce a self-supporting wall, or they can be set into a housing with motar as in a masonry practice. Edges of bricks can be mitered to allow cylindrical structures. Being completely inorganic, Eccosorb HT will not burn.

Reflectivity of Eccosorb HT is low when measured under free space conditions. This assures a low VSWR in the antenna feed line when the absorber is used in a cap application.

Circle No. 254 on Subscriber Service Card.

Skiatron Offers Line of Plug-In Printed Circuits

A complete line of plug-in printed circuits in modular form, which fully meet all applicable JAN specifications, has been developed by Skiatron Electrons & Television Corp.

The various types bales available include: multi-vibrators, high speed binary and decimal electronic counters, stepping switches, operational amplifiers, storage devices, for both short and long-term applications; pulse-shaping circuits, timing and delay circuits, diode logic "AND," "OR," and "NOT" circuits

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WEAPON SYSTEMS – Mechanical, aeronautical, civil or chemical engineering – with experience in research and development of aerochemistry and propulsion, astronautics, missile design and analysis, and thermodynamics of high speed missiles.

Qualified applicants are invited to send resumes and inquiries to Mr. K. A. Dunn.

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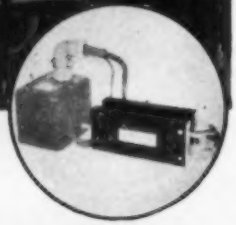
MISS-DISTANCE MEASURING SYSTEM
AN/USQ-11

— developed by Naval Ordnance Laboratory, Silver Spring, Maryland
— product-engineered and produced by Aircraft Armaments, Inc.

FOR TARGET DRONES



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OUTSTANDING FEATURES: Meets MIL-E-5272A 5400B, 16400 -- provides data in 2 min. -- requires transponder in drone only -- measures salvo firings -- determines miss on multiple targets. Target equipment (less power supply) under 2 lbs. Accuracy confirmed by field tests.

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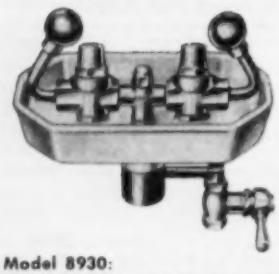
with **HAWS EMERGENCY EYE-WASH FOUNTAINS**



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Basic eye-wash model; enameled iron bowl, chrome plated brass heads. HAWS also offers eye and face wash fountains and drench showers.

Chemicals, foreign particles, caustics — all mean DANGER to eyes! Instant relief is vital! HAWS Eye-Wash Fountains flood the eyes with controlled water streams — soothing, relieving until medical aid arrives. Fool-proof operation activates fountain instantly, possibly avoiding permanent injury. HAWS Emergency Facilities are also widely used for routine cleansing of eyes as a precautionary measure. Write today for illustrated literature on HAWS complete line of emergency facilities.

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gating circuits and transmission gates, relay and switching circuits, voltage regulators, pulse generators, clocks and gated oscillators, and analogue to digital conversion systems and vice versa.

Although each type of bale performs a single major function, most types include versatile circuits that provide for ANDing, O Ring, non-critical triggering, fast rise time, choice of inversion, and a wide variation of operating parameters.

Special features of the bales are printed wiring, conservatively rated components, plated-through and eyeletted holes tube heat sinks, right-angle connectors, and rigid board mounting frames.

Circle No. 255 on Subscriber Service Card.

Gate Valve Simplifies Propellant Handling

The handling of hydrogen peroxide in the high velocity propellant applications is made simpler and safer by a gate valve, according to Hamer Valves, Inc.

Environmental tests have been conducted on the valve, subjecting it to the various conditions encountered in the use of hydrogen peroxide.

It was found that in dealing with hydrogen peroxides, rapid decomposition, it was advisable to design the valve with the seal on one side only—and to place the seal in the wedge. Thus, by placing the seal on one side only, the possibility of dangerous pressure building up through decomposition in the valve chest is eliminated.

Placing the seal in the wedge simplifies construction and replacement, and eliminates objectionable cavities. In the event the seal ring wears out or fails, it may be quickly and easily replaced.

The renewal seal is made of Teflon, a material that is long-lasting and possessing strong sealing characteristics for hydrogen peroxide. The wedge itself is micro-finished, with its eating surfaces precision-machined to provide an exacting metal-to-metal fit. The seat is integral with the valve body. The bore of the body is machine finished to provide a clean, smooth fluid contacting surface.

A tiller-type handwheel, exclusive with Hamer, affords maximum leverage for opening or closing the valve. The chevron packing is long lasting and sure sealing, being designed to expand as pressure increases, to prevent escapage at the stem.

Circle No. 256 on Subscriber Service Card.

Second Annual

GUIDED MISSILE ENCYCLOPEDIA

1958

An Exclusive Weapons Systems Roundup for Industry
Compiled and Written by
MISSILES & ROCKETS' Editors

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American Aviation Publications, Inc.

**Some of the specifications and performance figures given for the missiles and rockets in this encyclopedia have been calculated and have not necessarily been officially confirmed.*

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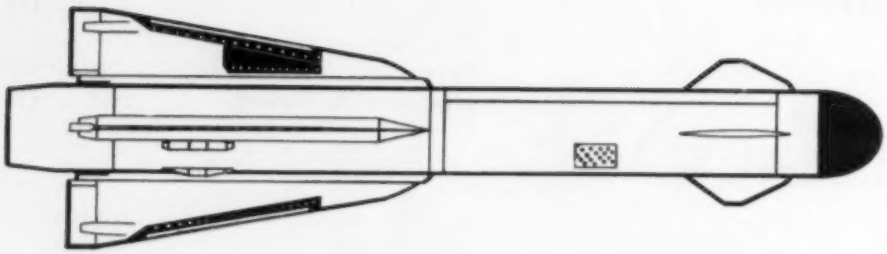
FALCON I



Falcon GAR-1D is an operational Air Force air-to-air missile designed to be launched from an interceptor aircraft for destruction of enemy bombers.

Developed by Hughes Aircraft Co., the *Falcon* is part of a complete weapon system for the Northrop F-89 and the Convair F-102A and F-106A interceptors. Guidance is by radar impulse generated by the interceptor.

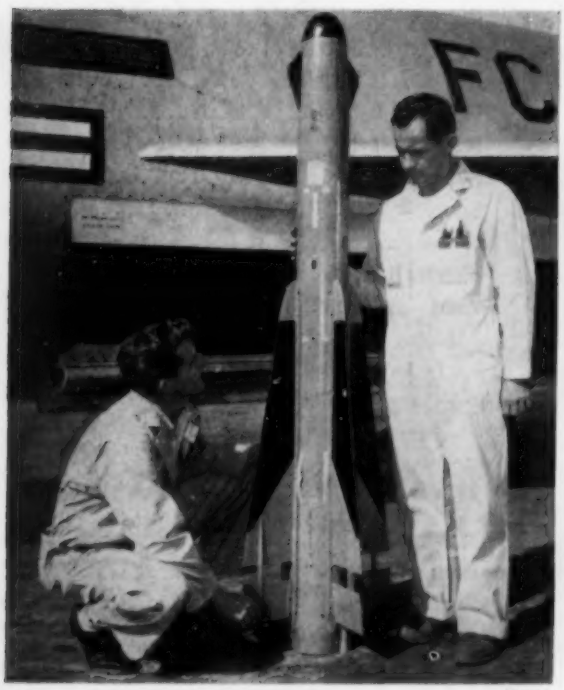
The *Falcon* need not be aimed precisely at the target, since the missile can sense the location of a selected target and seek it out. It can be launched on a climbing course from an interceptor that is far below the enemy bomber.

Latest model of this small lightweight missile has incorporated several aerodynamic improvements with greater altitude capability than the early GAR-1. Mainly, this involved changes in the steering control surfaces hinged to the trailing edge of the stabilizers. Main wings are fixed with movable canard control surfaces forward. The radar is housed in a blunt nose cone which fairs into a cylindrical fuselage.

Falcon is the smallest air-to-air guided missile in operational service, not excepting the *Sidewinder* and *Sparrow* group. It is slightly over six feet in length and weighs approximately 100 pounds. Range is about five miles with a maximum velocity of Mach 2. Propulsion power is supplied by a Thiokol solid propellant motor developing 6,000 pounds thrust.

GAR-1D production costs are currently under $15,000 a unit, with a further drop expected.

DESIGNATION:	GAR-1D
PRIME CONTRACTOR:	Hughes
STATUS:	Production, service use
RANGE:	5 miles (approx.)
VELOCITY:	Mach 2+
FRAME	
Manufacturer:	Hughes
Length (Overall), ft:	6
Diameter (Body), ft:	0.5
Span, ft:	2
Weight (Gross), lb:	100
Material (Major):	Magnesium
GUIDANCE	
Manufacturer:	Hughes
Type:	Radar homing
POWER PLANT	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast (1)
Thrust, lb:	6000
WARHEAD	
Type:	High explosive



USAF

GAR-ID has control improvements over GAR-I.

USAF

THE *FALCON* IS LIGHT enough (100 lbs.) to be handled by two men.

FALCON II

The addition of the *Falcon* GAR-2A to the Air Force arsenal of air-to-air weapons will probably mean mixed payloads on a single interceptor. A combination of radar and infra-red guided missiles on the same mission would greatly enhance the possibility of target interception.

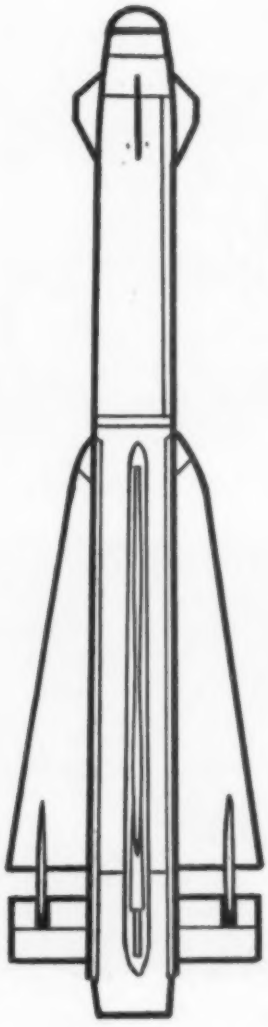
The configuration of the initial series of *Falcon* missiles has been altered slightly for the incorporation of the infra-red detection system. The IR detector is extremely sensitive, enabling the missile to "lock on" the target at greater ranges than was possible with the *Falcon* I-D.

Test shots against target drones carrying flares has been highly successful. In many instances, the missile destroyed the flare without damaging the drone.

The missile's sensitivity makes it very undesirable in cloud formations. It is for this reason that mixed loads will be carried by most interceptor aircraft. The wide-look angle of its infra-red "eye" also permits it to be launched far to one side of the target, therefore making it unnecessary for an interceptor pilot to confine himself to a dangerous tail attack.

Dimensions and weight of the 2A are almost the same as the GAR-I. It can be fired singly or in salvo. As in the earlier model, the 2A is powered by a Thiokol solid propellant rocket, which accelerates it to approximately Mach 2.

DESIGNATION:	GAR-2A
PRIME CONTRACTOR:	Hughes
STATUS:	Production, service use
RANGE:	5 miles (approx.)
VELOCITY:	Mach 2+
FRAME	
Manufacturer:	Hughes
Length (Overall), ft:	6
Diameter (Body), ft:	0.5
Span, ft:	2
Weight (Gross), lb:	100
Material (Major):	Magnesium, aluminum
GUIDANCE	
Manufacturer:	Hughes
Type:	Infra-red homing
POWER PLANT	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast (1)
Thrust, lb:	6,000
WARHEAD	
Type:	High explosive



USAF

THE PSEUDO-CANARD *Falcon* GAR-2A is equipped with infra-red detection system.

GENIE

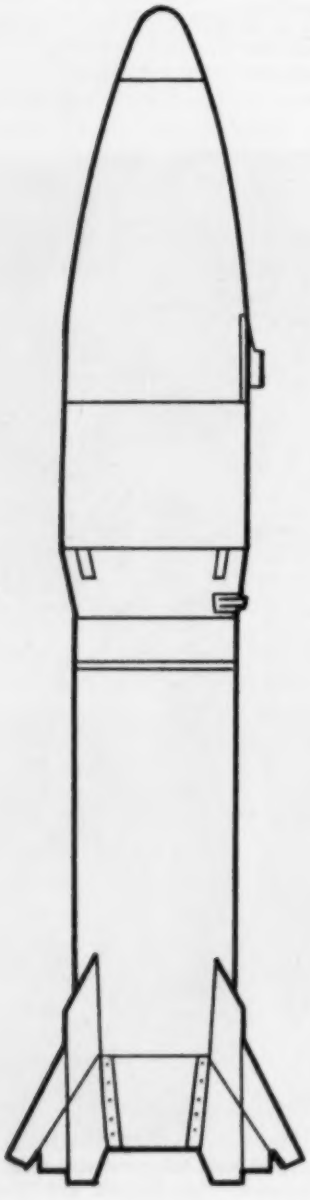
The *Genie* MB-I was the first air-to-air missile to be equipped with an atomic warhead. Since its inception, *Genie* has been tagged with a variety of names including *Ding-Dong, Bird Dog,* and *High-Card.*

Design studies for the *Genie* were started by Douglas Aircraft Co. in 1956, one year after the first atomic warhead packages for air-to-air missiles were tested to provide basic information on missile requirements.

First flight tests of the *Genie* were conducted in 1957 at AEC atomic firings. Carrier aircraft were Northrop F-89D's. Results of the tests were considered highly successful. The McDonnell F-101 Voodoo long range fighter is the latest aircraft to be equipped with these atomic missiles.

Current model of the *Genie* is powered by an Aerojet-General solid propellant rocket motor. Both liquid and solid replacements for the *Genie* are under development. First MB-Is were unguided, although a guided version has been designed and is under development.

DESIGNATION:	MB-1
PRIME CONTRACTOR:	Douglas
STATUS:	Production, service use
RANGE:	1.5 miles
FRAME	
Manufacturer:	Douglas
Length (Overall), ft:	8
Diameter (Body), ft:	1.25
Span, ft:	2
POWER PLANT	
Manufacturer:	Aerojet
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	Nuclear



Lower—McDonnell

AN ADVANCED MODEL of the *Genie* MB-1 is under development by Douglas.

Lower—McDonnell

McDONNELL F-101 Voodoo fighter in flight with two *Genies* externally mounted.

RASCAL

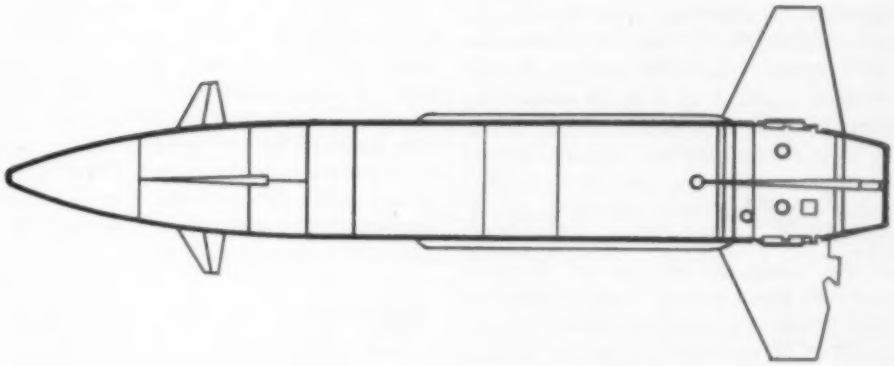
The *Rascal* GAM-63 is a liquid propellant rocket missile in development production by the Guided Missile Division of Bell Aircraft Corp. for the Air Force. An air-to-surface missile, nicknamed "Crew Saver," this weapon permits the delivery of nuclear warheads by piloted aircraft without endangering the crew to the hazards of local defense systems.

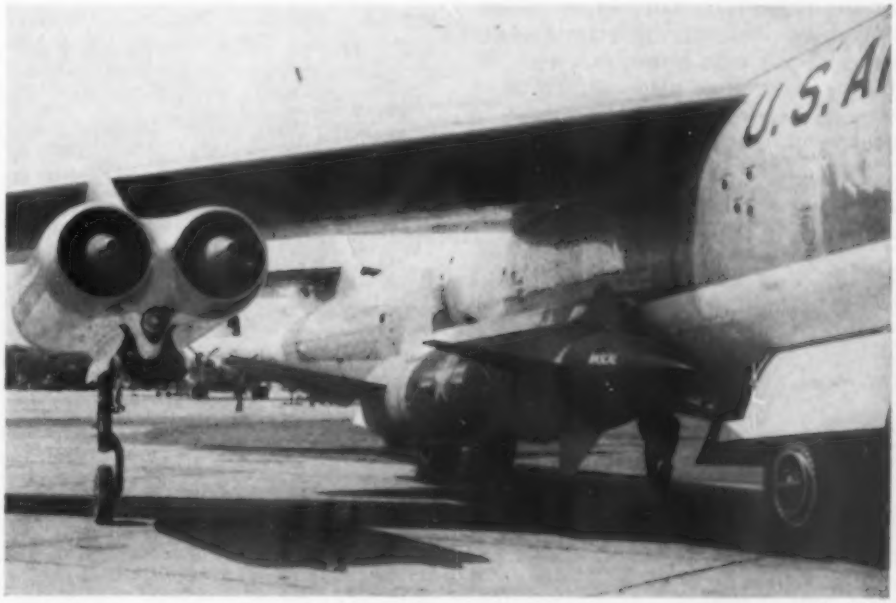
Stratojets, designated DB-47s, carry the *Rascal* on large pylons mounted on the right side of the fuselage under the wing. The missile is designed to be carried aloft by strategic bombers to be released miles from the target, allowing the crew to avoid defending interceptors and anti-aircraft missiles of the defended area.

The range of the *Rascal* is reported to be in excess of 100 miles. It utilizes a three-chambered liquid propellant rocket engine, developing a total thrust of 12,000 pounds. The missile achieves a velocity of approximately Mach 1.5 in the flight to the target.

Bell Aircraft, under Air Research and Development Command cognizance, has been responsible for the original design and development of the *Rascal* system.

DESIGNATION:	GAM-63
PRIME CONTRACTOR:	Bell
STATUS:	Production
RANGE:	100 miles max.
VELOCITY:	Mach 1.5 max.
FRAME	
Manufacturer:	Bell
Length (Overall), ft:	32
Diameter (Body), ft:	4
Span, ft:	14 (approx.)
Weight (Gross), lb:	13,000
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Bell, RCA, Texas Instruments
Type:	Radar command
POWER PLANT	
Manufacturer:	Bell
Propellants:	Liquid oxygen & alcohol
Type & Number:	Liquid, Vertical-in-line (3)
Thrust, lb:	12,000 @ 4000
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Boeing
Fueling:	GFE
Handling & Service:	Bell, American Mach. & Foundry
Transport Vehicles:	GFE





E. Hull

RASCAL, **SECURED TO DB-47 by an outrigger pylon, is fueled on ground.**

Bell

MISSILE STREAKS TOWARD target during flight tests at Holloman ADC, N.M.

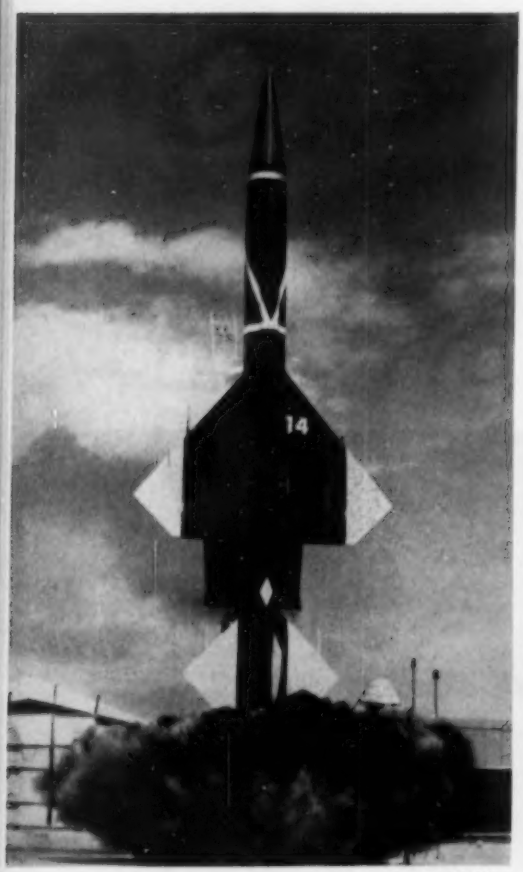
BOMARC

Bomarc 1M-99, the Air Force's supersonic pilotless interceptor, is launched vertically from an automatically opening launcher-shelter. Initial boost is supplied by a liquid rocket engine. When it reaches a speed at which its two ramjet engines become operational, they take over and climb to altitude, supplying the missile's cruise power.

An advanced version of *Bomarc* now in development, will employ a solid-propellant, external rocket booster in place of the liquid-propelled engine now in use. The range will be in excess of the present *Bomarc*, approximately 400 miles. This advanced version will be equipped with a nuclear warhead. Boeing Aircraft is planning a *Bomarc* training school on Harbor Island in Seattle scheduled for July.

Bomarc, at the moment, is the only missile in the U.S. arsenal capable of supplying the U.S. with medium-long-range defense by missiles. Essentially, it is a high-performance, unmanned aircraft and is probably the last of its type. Future anti-missile missiles and hyper-performance antiaircraft missiles will probably be rocket powered all the way. Meanwhile, the *Bomarc* base program could develop into one of the costliest in the entire U.S. defense program.

DESIGNATION:	IM-99
PRIME CONTRACTOR:	Boeing
STATUS:	Production
RANGE:	200-250 miles
VELOCITY:	Mach 2.5 max.
FRAME	
Manufacturer:	Boeing
Length (Overall), ft:	46.7
Diameter (Body), ft:	3
Span, ft:	18.17
Weight (Gross), lb:	15,000+
Material (Major):	Aluminum, stainless steel & magnesium
GUIDANCE	
Manufacturer:	Westinghouse
Type:	GCC/radar homing
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Aerojet
Propellants:	JP-4 and WFNA
Type & Number:	Liquid uncooled (1)
Thrust, lb:	35,000 (42,000 later model)
Second Stage	
Manufacturer:	Marquardt
Propellants:	Liquid
Type & Number:	24 inch ramjet (2)
Thrust, lb:	10,000-12,000
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	AMF, Food Machinery
Fueling:	Minneapolis-Honeywell, Brown Instruments
Radar & Ground Control:	Westinghouse, Remington Rand
Handling & Service	Burns & Roe, Farnsworth Elect.
Transport Vehicles:	Burns & Roe, AMF

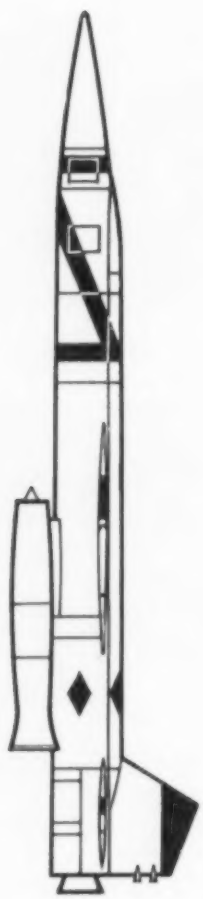


Boeing

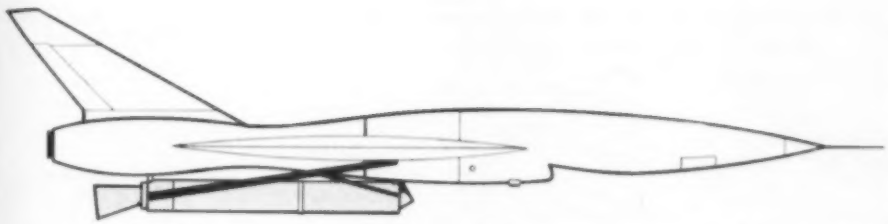
INITIAL BOOST from liquid engine.

Boeing

VERTICAL LAUNCH from shelter.



GOOSE



Goose is a large, long-range missile with a primary role to save the lives of SAC bomber crews and to enable them to complete their missions. It is a plastic, rocket-boosted, turbo-jet-powered decoy designed, developed and produced by Fairchild Engine & Airplane Corp. It is in the flight-test stage, and has produced one of the most trouble-free initial flight test records of any missile to date.

Zero-launched by solid propellant a single JATO-type booster, the *Goose* is designed to be launched so that it goes in in advance of attacking bombers with the hope that it will (a) confuse enemy radar and (b) tempt the enemy into expending its defensive hardware (AA missiles and shells) before the actual bombers come over the target with their payloads.

Gooses would be launched with a variety of target-simulating systems aimed at activating all the different kinds of defensive equipment and homing methods. Actually, there is no reason why some of these might not also be occasionally equipped with explosive payloads, in order to destroy specific enemy defensive targets on which they might be programmed to home.

The *Goose* is slated to be ordered into production shortly. It will be deployed an operated by SAC.

DESIGNATION:	SM-73
PRIME CONTRACTOR:	Fairchild
STATUS:	Development
RANGE:	2,000 miles +
(Ceiling:	50,000 ft. +)
VELOCITY:	High subsonic
FRAME	
Stages:	2
Length (Overall), ft:	60 (approx.)
Diameter (Body), ft.	4.5 (approx.)
Span, ft:	32 (approx.)
Material (Major):	Plastic
GUIDANCE	
Type:	Inertial
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Type & Number:	JATO (1)
Thrust, lb:	100,000 (approx.)
Second Stage	
Propellants:	JP
Type & Number:	Turbojet (1)
Thrust, lb:	5000+

USAF

DRAMATIC shot of decoy missile *Goose* zero-launched.

USAF

BIRD IS DESIGNED to protect bomber crews over enemy territory.

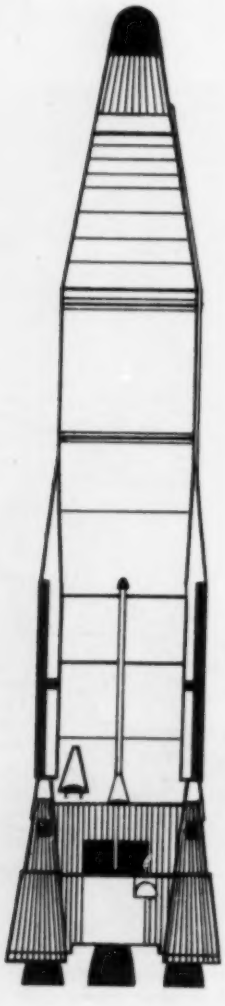
ATLAS

The SM-65 *Atlas*, the United States' first intercontinental ballistic missile project, is currently entering the final phase of its development program.

Several of the giant missiles have been fired since their first flight last June, with varying degrees of success. First flights were plagued with component failures ("bugs"), which now seem to be a thing of the past. In all flights, the missile has been powered only by twin booster engines. The next phase of the development program booster and sustainer engines.

Atlas begins its flight with all three engines in operation, a total of approximately 400,000 pounds of thrust. Several seconds after blast-off, the booster engines drop away and the missile continues with the lower thrust sustainer. Two small verniers located on the lower portion of the body supply roll control and thrust adjustment throughout powered flight.

DESIGNATION:	SM-65
PRIME CONTRACTOR:	Convair, Ramo-Wooldridge
STATUS:	Development production
RANGE:	5500-6200 miles
VELOCITY:	15,000 mph max.
FRAME	
Stages:	(2)
Manufacturer:	Convair
Length (Overall), ft:	75 (approx.)
Diameter (Body), ft:	10
Weight (Gross), lb:	243,000
Material (Major):	Steel
GUIDANCE	
Manufacturer:	GE/Burroughs
Type:	Radar-Doppler Command (Later models TITAN pure inertia)
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Rocketdyne
Propellants:	Liquid oxygen and kerosene
Type & Number:	Regenerative liquid (2)
Thrust, lb:	300,000 @ 150,000
Second Stage	
Manufacturer:	Rocketdyne
Propellants:	Liquid oxygen and kerosene
Type & Number:	Regenerative liquid (1)
Thrust, lb:	100,000
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Consolidated Western Steel, National Steel
Fueling:	Flexonics Corp., Reaction Motors
Radar & Ground Control:	Norden-Ketay, Potter Instrument
Handling & Service:	Goodyear Aircraft
Transport Vehicles:	Goodyear Aircraft
Check Out Equipment:	Caterpillar



USAF

ATLAS **ready for flight at Canaveral.**

Convair

BOOSTER and Vernier engines.

MACE

Martin

MACE **IS BOOSTED from trailer launcher at overland range.**

Martin

A 100,000-LB. thrust rocket starts *Mace* on its flight.

In the Tactical Air Command, the TM-76 *Mace* is the first of a second generation of aerodynamic cruise missiles. It is scheduled to replace the *Matador*, the Air Force's first pilotless bomber.

Mace is actually an improved *Matador* with increased range, speed, and a superior guidance system. In combat, tactical units will use the *Mace* to augment tactical bombers and fighter bombers.

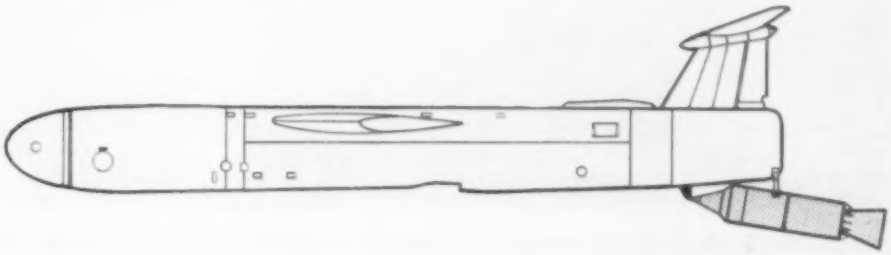
The missile will use either inertial or ATRAN guidance, depending upon the mission. The two systems are fundamentally interchangeable, with only minor production changes needed on the missile. The ATRAN guided *Mace* is designated the TM-76A, and the Inertial *Mace* is known as the TM-76B.

The inertial system, made by AC Sparkplug Division of General Motors, is a form of "memory navigation" which requires the location of launch point and target point for a successful mission.

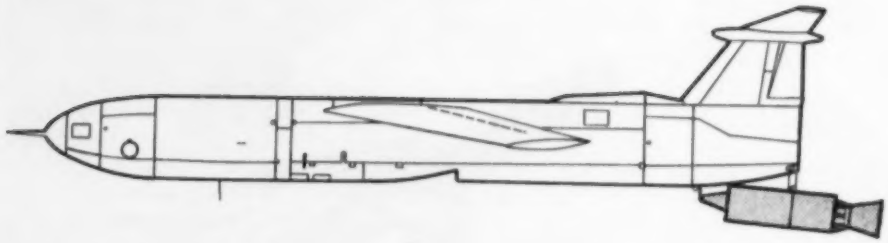
ATRAN, made by Goodyear Aircraft Corp., is a map matching system. The system permits extremely low-level penetration. Martin-Baltimore is the prime systems contractor.

The replacement of the warhead section with a recovery kit permits reuse of the *Mace* missile through parachute recovery.

DESIGNATION:	TM-76
PRIME CONTRACTOR:	Martin
STATUS:	Production
RANGE:	700 miles max.
VELOCITY:	Mach 0.9 max.
FRAME	
Manufacturer:	Martin
Length (Overall), ft.	44
Diameter (Body), ft:	4.5
Span, ft:	22.9
Weight (Gross), lb:	13,800
Material (Major):	Aluminum, magnesium
GUIDANCE	
Manufacturer:	Goodyear/AC
Type:	ATRAN/inertial
POWER PLANTS	
Booster	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast JATO (1)
Thrust, lb:	100,000
Sustainer	
Manufacturer:	Allison
Propellants:	JP
Type & Number:	J-33-A-41 turbojet (1)
Thrust, lb:	5200
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Goodyear
Fueling:	Goodyear
Radar & Ground Control:	Reeves Instruments, Kaustine Co.
Handling & Service:	Goodyear, Trailmobile
Transport Vehicles:	Goodyear, Four-Wheel Drive Co.



MATADOR



The TM-61 *Matador* was the first operational missile in the Air Force. It has now been in operation—with the Tactical Air Command in overseas areas—for the past four years.

Three versions of the *Matador* have been developed to date. The first, TM-61A, was equipped with a single MSQ radar guidance system. This system requires line-of-sight communication.

The TM-61C, in addition to the MSQ radar guidance system, employs the Shanicle system. The Shanicle system is believed to be the first known use of the Hyperbolic grid system. This is the creation of a grid pattern of radio waves by two separate transmitters. One transmitter directs the azimuth, the second the range.

The latest version of the *Matador* is the TM-61B. This model is several feet longer than the original version, and has clipped wings. It is reported to have greater range, as well as an improved guidance system requiring no assistance from the ground once the missile is launched. This version has now evolved into the *Mace* TM-76.

DESIGNATION:	TM-61C
PRIME CONTRACTOR:	Martin
STATUS:	Service use
RANGE:	700 miles
VELOCITY:	Mach 0.9 max.

FRAME	
Manufacturer:	Martin
Length (Overall), ft:	39.7
Diameter (Body), ft:	4.5
Span, ft:	27.85
Weight (Gross), lb:	12,000
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	GFE, Martin
Type:	MSQ Radar/Shanicle
POWER PLANTS	
Booster	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast JATO (1)
Thrust, lb:	52,000
Sustainer	
Manufacturer:	Allison
Propellants:	JP
Type & Number:	J-33 turbojet (1)
Thrust, lb:	4600
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Goodyear
Fueling:	Goodyear
Radar & Ground Control:	Reeves Instruments, Kaustine Co.
Handling & Service:	Trailmobile, Goodyear
Transport Vehicles:	Goodyear, Four-Wheel Drive Co.

Martin

MARTIN'S *Matador* can transport a 3,000-lb. warhead.

Martin

TACTICAL WINGS of the *Matador* are now operational.

SNARK

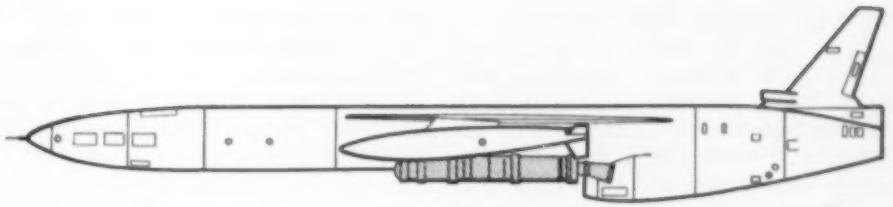
The Air Force surface-to-surface missile, the SM-62 *Snark*, is a high-altitude, swept-wing, single-engine, jet-propelled intercontinental guided missile. The Northrop *Snark* is the only operational intercontinental missile in the free world.

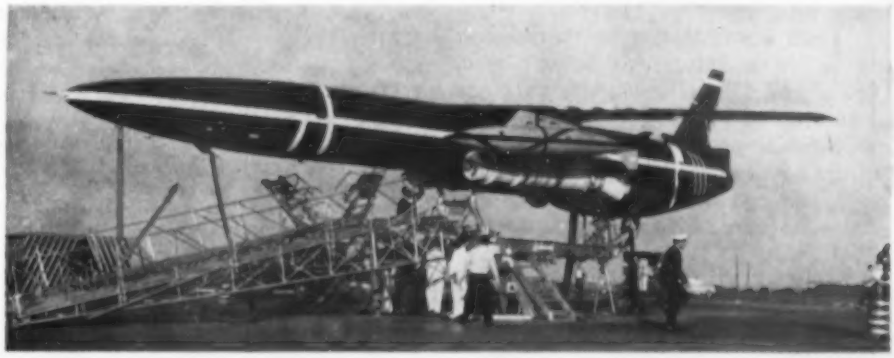
It has slim fuselage lines, with high-aspect ratio wings mounted near top and slightly forward of center of fuselage. Tail consists only of a vertical stabilizer. Engine air intake is located under fuselage and aft of wing.

Snark is powered during cruise flight by a Pratt & Whitney J-57 turbojet engine. Aerojet-General Corp. supplies the zero-length solid-propellant boosters which hurl it into the air.

The demand for an operational intercontinental missile and the advanced state of development of the *Snark* rang the death knell for the *Navaho* late last year. *Snark* will reign supreme in the intercontinental field until the advent of the operational ICBM. Meanwhile, *Snark* continues to post an admirable flight record.

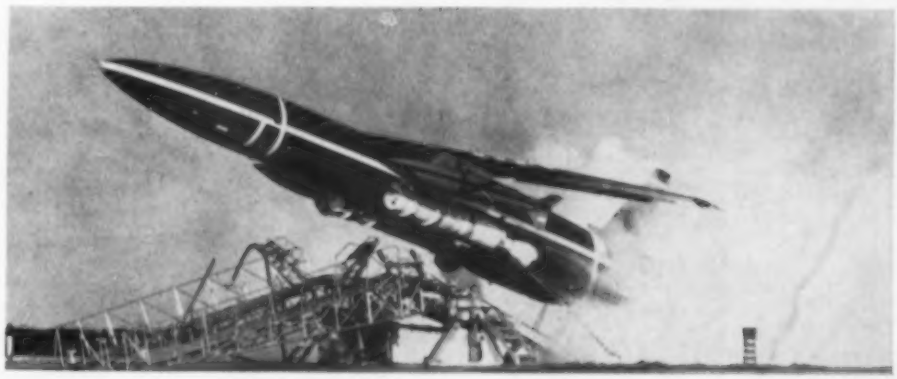
DESIGNATION:	SM-62
PRIME CONTRACTOR:	Northrop
STATUS:	Development, production, service use
RANGE:	5,000-6,500 miles
VELOCITY:	Mach 0.9 max.
FRAME	
Manufacturer:	Northrop
Length (Overall), ft:	74
Diameter (Body), ft:	4.5
Span, ft:	42
Weight (Gross), lb:	50,000 (approx.)
Material (Major):	Aluminum, magnesium
GUIDANCE	
Manufacturer:	Northrop
Type:	Stellar inertial
POWER PLANTS	
Booster	
Manufacturer:	Aerojet
Propellants:	Solid
Type & Number:	Cast JATO (2)
Thrust, lb:	66,000 @ 33,000
Sustainer	
Manufacturer:	Pratt & Whitney
Propellants:	Liquid
Type & Number:	J-57 turbojet (1)
Thrust, lb:	11,000
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	American Car & Foundry
Fueling:	GFE
Radar & Ground Control:	Hallamore Electronics, Radiophone Co.
Handling & Service:	GFE
Transport Vehicles:	GFE





Northrop

MISSILE IS READIED for long range test flight from Cape Canaveral, Fla.



Northrop

THE 25-TON *Snark* clears its zero-length launcher with a 66,000-lb. assist.

Carl Byoir

***SNARK* CAN BE quickly readied for action with its mobile transport-launcher.**

THOR

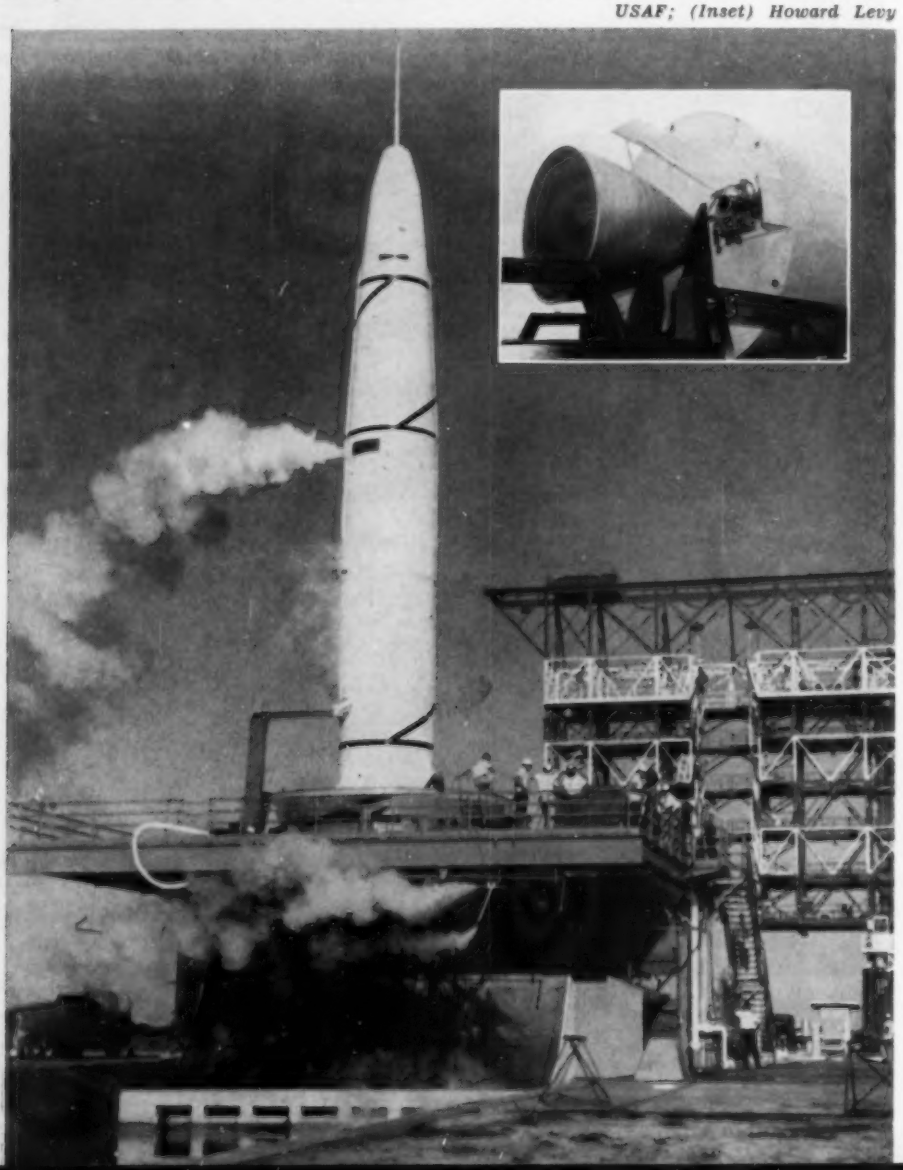
The Douglas *Thor* will play a major role in future weapons and space flight programs. The *Thor* will probably be picked (over the *Jupiter*) as the free world's IRBM arm of retaliation. *Thor* has been slated to boost three lunar probes and launch a reconnaissance satellite, in addition to its role in the *Thor-Able* re-entry test vehicle program.

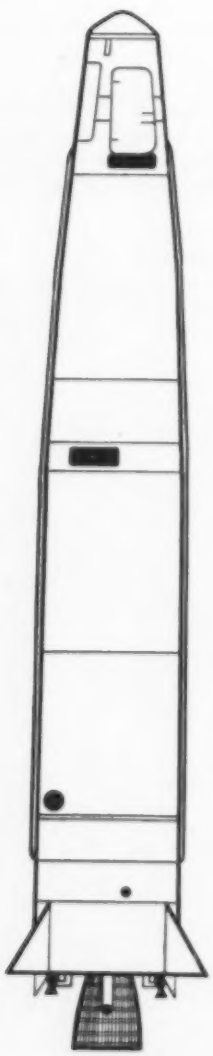
Final determination on the number of IRBM squadrons to be deployed, (*Thor* and *Jupiter*), will not be made until later this year.

Thor is powered by a 150,000-lb. thrust liquid propellant engine now being produced at Rocketdyne Neosho. Propellants are liquid oxygen and RP-1, a high grade kerosene. In addition to the gimbaling action of the sustainer, thrust adjustment and roll control are obtained by two vernier engines located at the base of the missile on each side of the sustainer (see insert).

DESIGNATION:	SM-75
PRIME CONTRACTOR:	Douglas, Ramo-Wooldridge
STATUS:	Development production
RANGE:	1,500-2,200 Miles
VELOCITY:	10,000 mph max.
FRAME	
Manufacturer:	Douglas
Length (Overall), ft:	62
Diameter (Body), ft:	9
Weight (Gross), lb:	100,000
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	AC Spark Plug
Type:	Inertial
POWER PLANT	
Manufacturer:	Rocketdyne
Propellants:	Liquid Oxygen and Kerosene
Type & Number:	Regenerative cooled, liquid (1)
Thrust, lb:	165,000
WARHEAD	
Type:	Nuclear
Nose Cone:	GE
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Food Machinery
Fueling:	Air Prod., Cambridge Corp.
Radar & Ground Control:	AC Spark Plugs
Handling & Service:	Douglas, Food Machinery
Transport Vehicles:	Douglas, Food Machinery

LIQUID OXYGEN is "topped off" as *Thor* is prepared for test flight from the Cape.
USAF; (Inset) Howard Levy





TITAN

The Air Force's *Titan* WS-107 intercontinental ballistic missile's airframe is under construction at the Martin Co., Denver. Development of the *Titan* was ordered late in 1955.

Titan is a two-stage missile. The first stage engine will transport the vehicle to altitude before the final stage ignites, differing from the *Atlas* system where all three motors are fired simultaneously on the ground.

Titan does not duplicate the *Atlas*, although some of its components are common to both systems. The airframes and propulsion systems are quite different. however, so it is unlikely that the two missiles can be considered interchangeable.

DESIGNATION: SM-68
PRIME CONTRACTOR: Martin, Ramo-Wooldridge
STATUS: Research-Development
RANGE: 5,500 miles max
VELOCITY: 15,000 mph max.

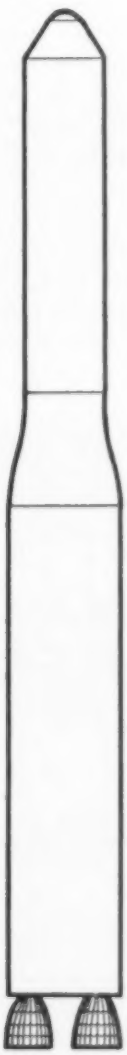
FRAME
- Stages: 2
- Manufacturer: Martin
- Length (Overall), ft: 90
- Diameter (Body), ft: 10
- Weight (Gross), lb: 222,000
- Material (Major): Aluminum

GUIDANCE
- Manufacturer: Arma, Minneapolis-Honeywell/Bell Tel. Lab., Remington Rand
- Type: Inertial/radio inertial

POWER PLANTS
- First Stage (Booster)
  - Manufacturer: Aerojet
  - Propellants: Liquid Oxygen and JP-6
  - Type & Number: Regenerative, liquid (2)
  - Thrust, lb: 300,000
- Second Stage
  - Manufacturer: Aerojet
  - Propellants: Liquid Oxygen and JP-6
  - Type & Number: Regenerative cooled liquid (1)
  - Thrust, lb: 60,000

WARHEAD
- Type: Nuclear
- Nose Cone: Avco

GROUND SUPPORT MAJOR CONTRACTORS
- Launcher: Kaiser Steel, Baldwin-Lima-Hamilton, Space Corp.
- Fueling: Air Products
- Radar & Ground Control: Hallamore Electronics
- Handling & Service: Hallamore Electronics
- Transport Vehicles: North American



AN ARTIST'S CONCEPTION of the two-stage Martin *Titan* ICBM in flight.

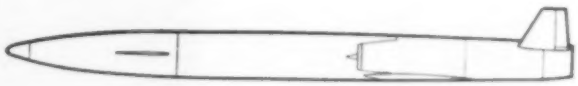
DYNA-SOAR

Dyna-Soar had its birth first in 1935 as an idea and design study by Dr. Eugen Sänger. Now it is in the design-study stage under a competition between two major industrial teams—one under Boeing, consisting of Ramo-Wooldridge, GE-Syracuse; NAA's Autonetics and Missile Development divisions, Aerojet-General, and Chance-Vought; the other under Martin and consisting of Bell, Goodyear, AMF, Bendix and Minneapolis Honeywell. *Dyna-Soar* would have a range of 12,000-to-25,000 miles; would be rocket-boosted to a 100-to-150-mile altitude and then would glide (assisted by small sustainer rockets) over target and to a landing. The vehicle would be manned.

GREEN QUAIL

Green Quail is one of a large number of diversionary missiles under development for the Air Force. It is reported to be a surface-to-surface bird of the *Corvus* family. Reported contractors are: McDonnell Aircraft for prime systems and Sommers Gyroscope for guidance. Though first flights were scheduled for sometime in 1958, there have been no reports of such a flight yet. The role of the missile as a coutermeasures device for attacking aircraft is increasing in importance. It is reported to be encountering technical problems, particularly in the engine. Suggested launching platforms are the B-52 and B-70.

HOUND DOG



Hound Dog was the subject of an intense round of proposing by almost all the major airframe companies last fall with the winner being North American Aircraft. The missile is understood to be a ramjet-powered air-to-surface bird, and is a follow-on to the Bell *Rascal*. Original design specifications called for one under each wing of a B-52 with the capability built into a plane-carried computer to shoot simultaneously at two different targets. Guidance is probably a form of inertial navigation, corrected by doppler radar.

MINUTEMAN

Minuteman is a 5,000 mile solid propellant ICBM to replace *Atlas* and *Titan*. Contractors are not yet named. Vehicles would be placed on subterranean platforms scattered around an individual launching site. The individual launchers would control a number of missiles, and the launcher would also be underground. Solid propellants would allow long storage without upkeep, and the underground storage protecting from weather. The *Minuteman* would be ready to go at all times. The number of troops to operate will be substantially smaller than *Atlas* and *Titan*.

WAGTAIL

Wagtail is an air-to-ground missile is probably the most radical of all concepts now in the research and development phase. It reportedly used forward-firing rockets after launch to achieve a very low velocity (approaching zero) before ignition of the solid propellant engine. This means that the missile can be launched from a low flying bomber and then climb over obstacles such as hills to get to its target. Contractors for the *Wagtail* have not been named but Minneapolis-Honeywell is rumored to be either the prime or the guidance system sub-contractor. It is contemplated that *Wagtail* will be used by both the B-52 and the B-70 chemical bomber.

HAWK I

The Army's surface-to-air guided missile, *Hawk*, is designed to be used primarily against low-flying craft. The missile will be deployed by both the Army and the Marine Corps. *Hawk* is carried on a launcher from which three missiles can be fired in rapid succession. This highly mobile system is capable of being transported with a minimum number of vehicles on the highway, or by helicopter and conventional aircraft.

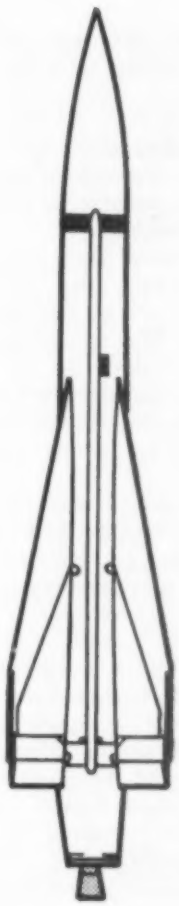
Unusual radar instrumentation has been designed and installed in the *Hawk* to gain effectiveness in the so-called "blind zone" of conventional radars.

The *Hawk* uses a solid propellant system developed by Thiokol Chemical Corp. The motors are currently in production at Aerojet Sacramento.

Each battery of 36 missiles requires some 40 acres for emplacement. For safety and economy, the missiles are stored underground. The twelve launcher emplacements are covered by balloon-like domes. Missiles are fired through domes, which protect launchers against the weather.

First emplacements will be located in New York City and Washington, D.C. to complement *Nike* defenses of those major metropolitan complexes.

DESIGNATION:	XM3
PRIME CONTRACTOR:	Raytheon
STATUS:	Development production
RANGE:	22 miles max.
FRAME	
Stages:	2
Manufacturer:	Northrop
Length (Overall), ft:	17
Diameter (Body), ft:	1.2
Span, ft:	4
Weight (Gross), lb:	1200
Material (Major):	Steel
GUIDANCE	
Manufacturer:	Raytheon
Type:	Radar homing
POWER PLANTS	
First Stage	
Manufacturer:	Aerojet, Thiokol
Propellants:	Solid
Type & Number:	Cast (1)
Second Stage	
Manufacturer:	Aerojet, Thiokol
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	High Explosive by Picatinny Arsenal
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Northrop, Food Machinery
Radar & Ground Control:	Raytheon
Handling & Service:	Raytheon, Northrop, Food Machinery
Transport Vehicles:	Northrop, Food Machinery



Army

VERSATILE *Hawk* can be transported on roads by helicopter.

Army

RAYTHEON is prime contractor development and production.

NIKE-AJAX

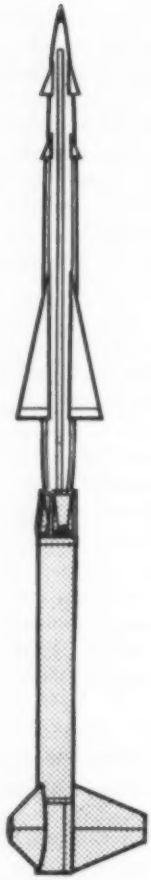
The last *Nike-Ajax* has now been shipped—passing from the production scene. It was the United States' first surface-to-surface missile, with over 10,000 manufactured and delivered to installations throughout the country. It is currently undergoing replacement by the *Nike-Hercules*.

The original *Nike* project was initiated in 1945, after years of guided missile research by the Bell Telephone Labs. The Western Electric Co. was the prime contractor to the Army, responsible for development and production of the system. Douglas was responsible for frame and launching components.

Nike-Ajax is attached to a solid propellant booster half the missile's length. The booster accelerates the missile to supersonic speeds, separates in a matter of seconds, and falls to a predetermined booster area.

Nike-Ajax is normally fired from an almost vertical position, and is therefore capable of meeting an enemy attack from any direction. Calculations are made and decisions reached electronically. Any evasive action by the target plane is futile—it is detected instantaneously — and the missile's course is altered accordingly.

DESIGNATION:	XSAM-A-7
PRIME CONTRACTOR:	Western Electric
STATUS:	Production, service use
RANGE:	35 miles max.
VELOCITY:	1500 mph
FRAME	
Stages:	2
Manufacturer:	Douglas, Borg-Warner (booster)
Length (Overall), ft:	21 (35.5 with (booster)
Diameter (Body), ft:	1
Span, ft:	4
Weight (Gross), lb:	2000+ (Missile) plus Booster)
Material (Major):	Aluminum, magnesium and steel
GUIDANCE	
Manufacturer:	Western Electric
Type:	Command
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Goodyear
Propellants:	Solid
Type & Number:	Cast uncooled (1)
Second Stage	
Manufacturer:	GFE
Propellants:	Nitric acid and JP
Type & Number:	Liquid, cooled (1)
Thrust, lb:	2600
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Douglas, Consolidated Western Steel
Radar & Ground Control:	Western Electric
Handling & Service:	Douglas, Wayne Pump
Transport Vehicles:	Fruehauf



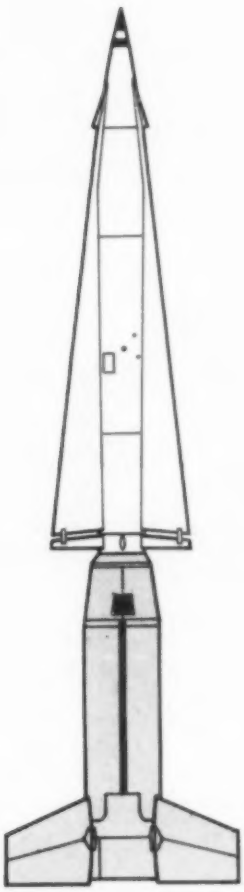
Army

***NIKE* poised for launching at White Sands.**

Army

THE *AJAX* has been installed at over 100 sites in 15 defense areas within the U.S.

NIKE-HERCULES



The *Nike-Hercules*, with many times the destructive power of the original *Nike-Ajax*, has reached a substantial rate of production, according to the Western Electric Company, prime contractor of the system.

The new system will be in the hands of operational *Nike* batteries around the country in the relatively near future, with first units to become operational in northeast U.S. and the Midwest. *Hercules* systems may eventually replace all *Ajax* systems. The *Nike-Hercules* system will make full use of present *Nike-Ajax* sites and components. Replacement of the *Ajax* ground guidance equipment and modifications to launching equipment will make it possible to fire both *Ajax* and *Hercules*.

Research and development studies on the *Hercules* were made by the Army Ordnance Corps, Bell Telephone Labs, Western Electric and Douglas.

The ground guidance and control equipment, plus the electronic guidance package, is manufactured by the Western Electric Co.

The *Hercules* system also uses three radars, a computer, automatic plotting boards, power generators and miscellaneous equipment in the Ground Guidance system.

DESIGNATION:	XSAM-A-25
PRIME CONTRACTOR:	Western Electric
STATUS:	Production
RANGE:	75 miles max.
VELOCITY:	2200 mph (approx.)
FRAME	
Stages:	2
Manufacturer:	Douglas, Goodyear, Borg Warner
Length (Overall), ft:	27 (41.5 with booster)
Diameter (Body), ft:	2.5
Span, ft:	8.75 (approx.)
Material (Major):	Aluminum, magnesium and steel
GUIDANCE	
Manufacturer:	Western Electric
Type:	Command
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Radford Arsenal
Propellants:	Solid
Type & Number:	Cast uncooled (4)
Second Stage	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast, uncooled (1)
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Douglas, American Machine & Foundry, Wayne Pump
Radar & Ground Control:	Western Electric
Handling & Service:	Douglas, Consolidated Western Steel, Wayne Pump
Transport Vehicles:	Douglas, Fruehauf

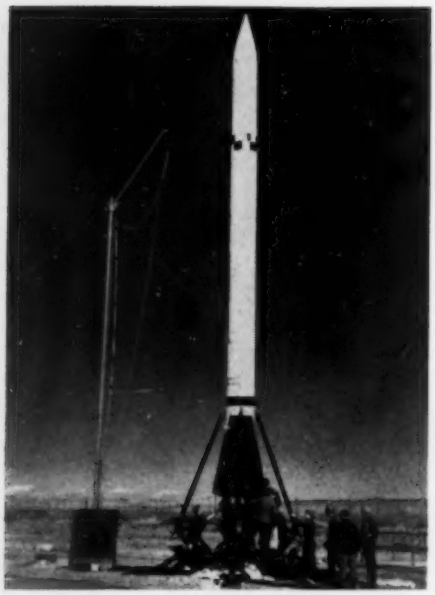
Army

THE *Nike-Hercules* will be integrated into present *Ajax* launching sites.

Army

LAUNCHING requires four *Ajax* boosters.

CORPORAL



Army

SLENDER 46-ft. *Corporal* erected on pad.

Army

THE *CORPORAL* is positioned on its pad by a LeTourneau transport-erector.

The Army's *Corporal* was this country's first ballistic missile.

The liquid-propelled, 30-inch diameter missile is produced by the Firestone Tire & Rubber guided missile division.

Topmost section, as it sits on the launching pad, is the 8-foot-long nose which houses the warhead. Immediately below, lies the guidance stowage compartment; followed, in sequence, by a cluster of cells to carry compressed air to pressurize the two propellant tanks, the propellant valve system, the rocket engine and the guidance vanes and rudders.

Also included in the aft compartment of the missile is the servo-motor system to actuate the jet vanes and rudders, as well as miscellaneous air pressure regulating valves.

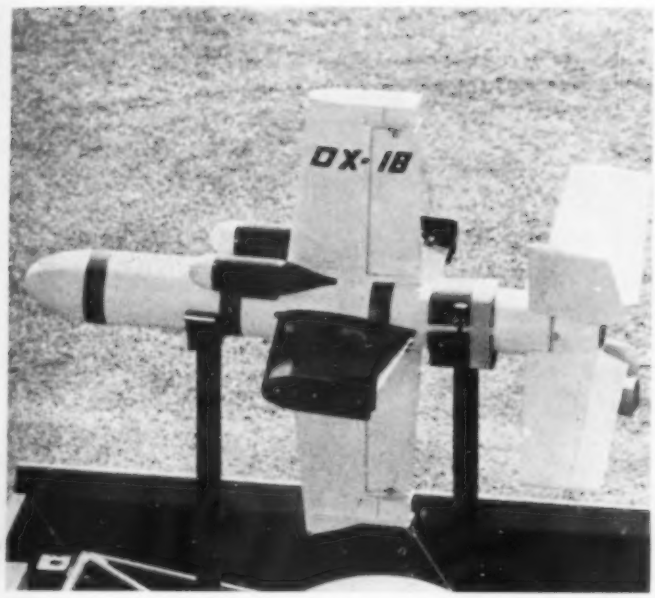
In *Corporal's* flight to its objective, it follows a ballistic trajectory. Visibility and weather conditions place no restrictions on its use.

The launcher is a simple device consisting of a light metal take-off pedestal. A self-propelled, electrically-operated erector places the missile in firing position, when ready, on the take-off pedestal.

Basic firing data is computed for the guidance equipment and entered as "dial settings" before the missile is launched. After the rocket is fired, minor corrections are made to the trajectory to insure and accurate impact. The 75-mile range missile is slated to be replaced in the near future by the *Sergeant*.

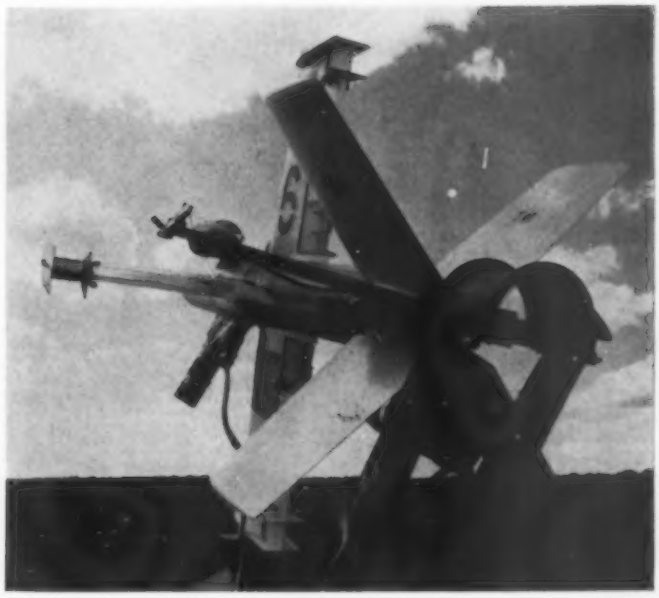
DESIGNATION:	XM4E1
PRIME CONTRACTOR:	Gilfillan, Firestone
STATUS:	Production, service use
RANGE:	100 miles max.
FRAME	
Manufacturer:	Firestone
Length (Overall), ft:	46
Diameter (Body), ft:	2.5
Weight (Gross), lb:	12,000
Material (Major):	Steel
GUIDANCE	
Manufacturer:	Gilfillan, Clary Multiplier Co.
Type:	Command
POWER PLANT	
Manufacturer:	Ryan
Propellants:	Nitric acid and aniline
Type & Number:	Liquid cooled (1)
WARHEAD	
Type:	High explosive or nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Firestone
Fueling:	Firestone, GFE
Radar & Ground Control:	Gilfillan, Motorola
Handling & Service:	Le Tourneau, Firestone
Transport Vehicles:	GFE

DART



Army

DART **WARHEAD is capable of penetrating heaviest armor.**



Army

THE *DART* will be employed by infantry and armored units.

The Army's wire guided missile, *Dart*, is a simple, but effective anti-tank, anti-placement weapon to be employed by infantry or armored units.

Dart is maneuverable enough to make it relatively safe from machine gun and anti-aircraft fire. It is propelled by a smokeless rocket propellant manufactured by Grand Central.

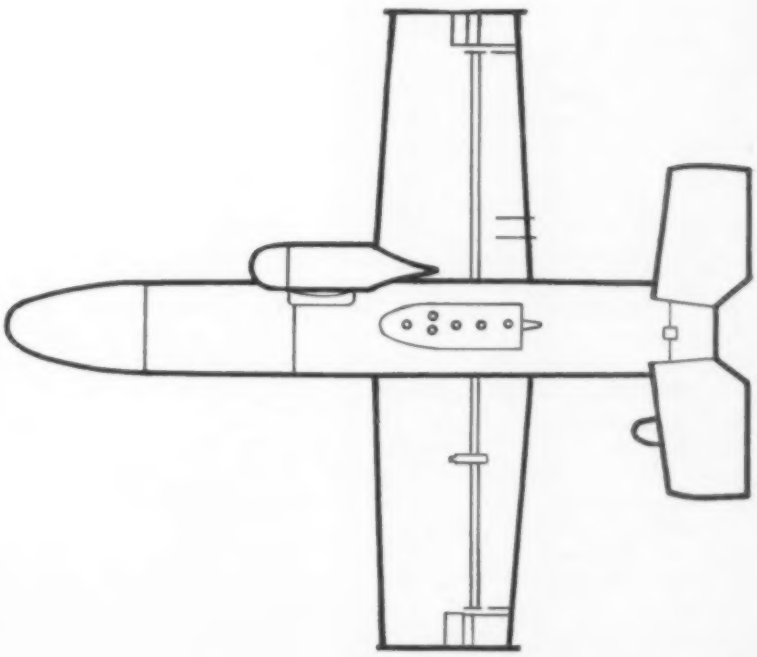
The guidance system automatically computes problems, and transmits the signals to the missile by means of electrical impulses through the wire. Guidance operation is through operator line-of-sight determination. *Dart* is launched from a light-weight launcher, and can be fired from either a fixed or mobile position. One man can fire.

The missile system was developed by the Aerophysics Development Corp., and is presently in production at the Utica Division of Curtiss-Wright.

DESIGNATION:	XSSM-A-23
PRIME CONTRACTOR:	Aerophysics Development Corp.
STATUS:	Production
RANGE:	6000 ft.
VELOCITY:	Mach 1
FRAME	
Manufacturer:	Utica-Bend
Length (Overall), ft:	5
Diameter (Body), ft:	.8
Span, ft:	3
Weight (Gross), lb:	100
GUIDANCE	
Manufacturer:	Wagner
Type:	Optical
POWER PLANT	
Manufacturer:	Grand Central
Propellants:	Solid
Type & Number:	Uncooled (1)
WARHEAD	
Type:	High explosive

GROUND SUPPORT MAJOR CONTRACTORS

Launcher:	Aerophysics Development Corp.
Fueling:	Grand Central
Radar & Ground Control:	Aerophysics Development Corp.
Handling & Service:	Aerophysics Development Corp.
Transport Vehicles:	GFE



HONEST-JOHN

Army

HONEST JOHN **is in service overseas with U.S. and NATO troop units.**

E. Hull

MISSILE USES a variety of warheads, including atomic.

The Army's *Honest John* is a free-flight rocket, having no electronic controls. It will be used in providing close fire support for ground operations. Extreme mobility and simplicity are incorporated in the rocket, which can be fired by less than six men, if it should be necessary.

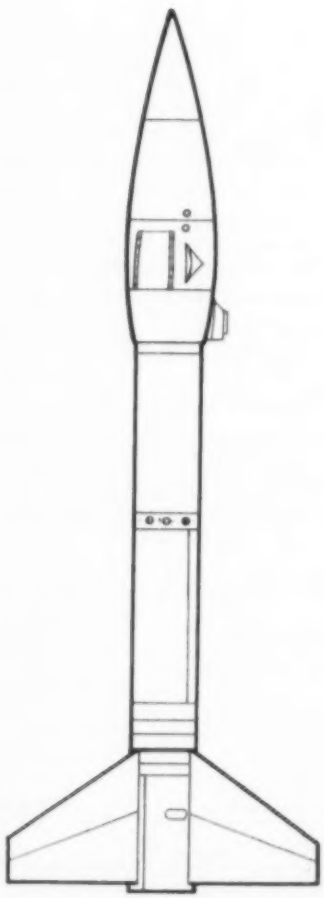
Honest John is propelled by a solid propellant rocket, and a slow spin is produced by small spin rockets. It is fired from a mobile, self-propelled launcher and can carry an atomic or high-explosive warhead.

The basic idea for a large calibre artillery rocket was first outlined to Douglas by Army Ordnance in June, 1950. Aerodynamics and engineering studies, under the technical supervision of the Redstone Arsenal, Huntsville, Alabama, dictated a number of modifications of what were the original specifications.

Effectiveness of the weapon was then demonstrated in a series of tests at the White Sands Proving Ground, New Mexico. Initial tests completed in August, 1951, justified production of additional models. Successful tests with the improved rockets resulted in contracts being let for large-scale production.

Major parts of the *Honest John* rocket—such as the head compartment, fins, pedestal and motor—are assembled at the factory or arsenal. Final assembly of the explosive warhead and fins to the rocket takes place near the firing site. The rocket is then rapidly moved forward on the self-propelled launcher.

DESIGNATION:	M-30
PRIME CONTRACTOR:	Douglas, Emerson Electric
STATUS:	Production, service use
RANGE:	18-20 miles
VELOCITY:	1120 mph
FRAME	
Manufacturer:	Douglas
Length (Overall), ft:	27
Diameter (Body), ft:	2.5
Span, ft:	8
Weight (Gross), lb:	6000
Material (Major):	Steel
GUIDANCE	
Type:	Unguided
POWER PLANT	
Manufacturer:	Hercules
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Rock Island Arsenal
Transport Vehicles:	OTAC



JUPITER

Development of the *Jupiter* IRBM began in mid-1955 when the Army, Navy, and Chrysler Corp. met to study the feasibility of adopting an Army IRBM design for operational use within a fleet ballistic missile system. First contract for engineering and production work on the *Jupiter* missile system was awarded to Chrysler in June, 1956.

The *Jupiter*, designed by the Army's Ballistic Missile Agency of Huntsville, Alabama, is designed to transport a nuclear warhead over a 1,500 mile distance and slightly beyond. It is a missile that signifies the ultimate in simplicity—its constant diameter cylindrical body is slightly under 60 ft. in length and 9 ft. in diameter. The control and guidance section of the missile is located in a conical section forward of the top propellant kerosene tank. The warhead, mounted forward of the control section, is a continuation of the conical section with a bluff re-entry tip.

Scale models of the re-entry nose cone for the *Jupiter* were recovered successfully after being fired 3,000 miles over the Atlantic on a *Jupiter-C* test vehicle flight during the fall of 1957. Recently, an operational nose cone was recovered successfully after a 1,500 mile flight (see launch photo, below right).

Jupiter is powered by a Rocketdyne liquid propellant rocket engine, developing approximately 150,000-lb. thrust. Roll control is supplied by swiveling the exhaust of the gas generator.

DESIGNATION:	SM-78
PRIME CONTRACTOR:	Chrysler
STATUS:	Development, production
RANGE:	1500-2000 miles
VELOCITY:	10,000 mph
FRAME	
Manufacturer:	Chrysler
Length (Overall), ft:	58
Diameter (Body), ft:	8.75
Weight (Gross), lb:	105,000
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Ford Instrument Co.
Type:	Inertial
POWER PLANT	
Manufacturer:	Rocketdyne
Propellants:	Liquid Oxygen and kerosene
Type & Number:	Regenerative cooled (1)
Thrust, lb:	150,000-165,000
WARHEAD	
Type:	Nuclear
Nose Cone:	Goodyear Aircraft

JUPITER **test vehicle shortly after launch, rises on a tail of flame.**

Army

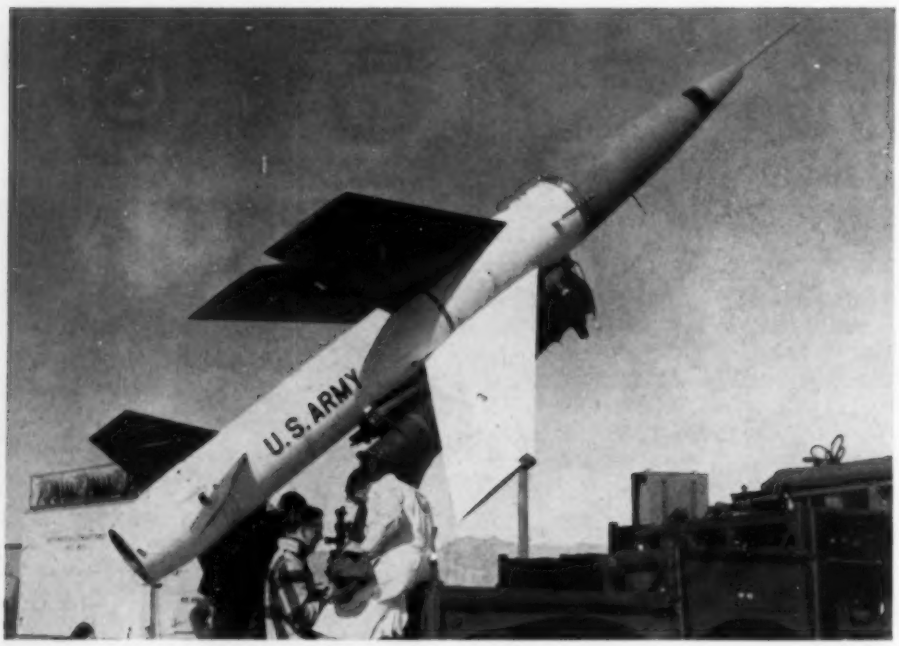
THE FIRST SUCCESSFUL *Jupiter* **re-entry nose cone tests Cape Canaveral.**

Army

LACROSSE

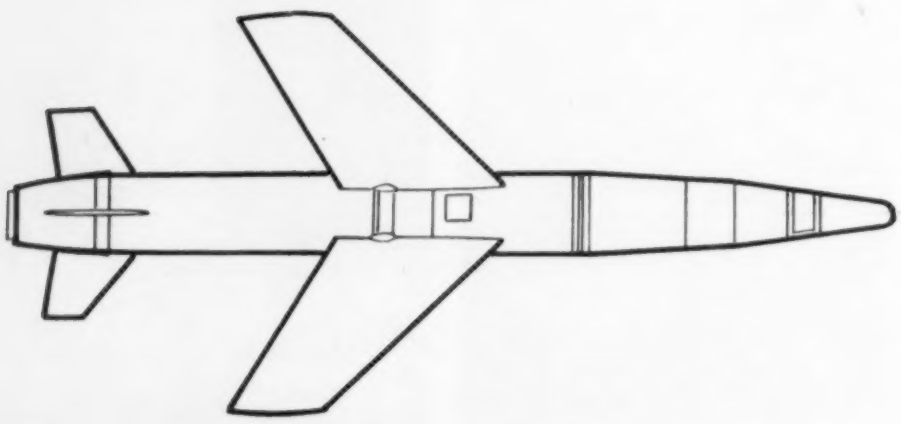
Army

LACROSSE was developed by Cornell Aeronautical Lab, with production by Martin.



Army

AN EARLY TEST MODEL of *Lacrosse* is prepared for launching at White Sands, N.M.



The *Lacrosse*, an Army surface-to-surface artillery guided missile, has been sucessfully developed and is in production, the Army announced early in 1957.

According to the Army, the present *Lacrosse* system, after being launched from a position in the rear of the combat area, is guided to its target by a forward observer. Using airborne control, the missile would be controlled to its target from a position above the battlefield, presumably by Army aircraft.

Because of its extreme accuracy and high payload, *Lacrosse* provides one-shot destruction of difficult targets such as pillboxes.

The present *Lacrosse* uses a launcher mounted on a stardard Army truck. According to Cornell Aeronautical Laboratory, work on a lightweight launcher, as well as other system equipment, is underway to make equipment transportable by helicopter.

Lacrosse has four fins positioned 45 degrees from the plane of the wings and the aft of the fuselage, which are movable for flight control and stability. The four swept wings and four movable tail fins, which control pitch, yaw and roll, snap into slots in the body.

Just prior to launching, the missile undergoes a complete test, using a missile automatic checker which tests all phases of the missile before firing. This equipment can be airlifted to battle areas if necessary.

DESIGNATION:	SSM-A-12
PRIME CONTRACTOR:	Cornell Aero Lab., Martin
STATUS:	Production
RANGE:	20 miles
VELOCITY:	Mach 2
FRAME	
Manufacturer:	Martin
Length (Overall), ft:	19.5
Diameter (Body), ft:	1.7
Span, ft:	9
GUIDANCE	
Manufacturer:	Federal Telephone Labs.
Type:	Terminal
POWER PLANT	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	Nuclear capability
GROUND SUPPORT MAJOR CONTRACTORS	
Radar & Ground Control:	Federal Telecommunication, Farrand Optical

LITTLE JOHN

Little John was designed and developed by Redstone Arsenal to supplement the *Honest John*. It is a free-flight artillery weapon with high accuracy, simplicity of design and operation. The missile has no electronic controls. It has a range equivalent to medium-to-long-range artillery.

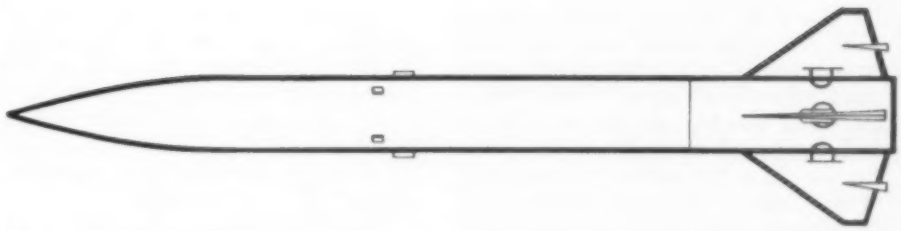
The dimensions of *Little John* are about one-third of *Honest John's*, and its weight one-sixth of its predecessor. *Little John* can be carried by helicopter and cenventional aircraft.

Even under severe weather conditions, *Little John* has remarkable accuracy. It is an artillery-type rocket intended for use by the Army airborne divisions.

This "baby brother" of the *Honest John*, combined with the *Lacrosse*, will eventually replace the *Honest John*. *Little John* represents the growth of a new family of rocket weapons that will ease logistical problems and provide a wider range of warhead selection. In combination with *Honest John*, *Lacrosse*, and *Sergeant*, the Army will have a tactical fire support that will have little need for close air support.

Propellant for the solid fueled rocket is produced by Allegheny Ballistics Lab, with Consolidated Western Steel supplying motor parts. Emerson Electric manufactures the air frame, and the Army Rock Island Arsenal provides the launchers.

DESIGNATION:	XM-47
PRIME CONTRACTOR:	Emerson Electric
STATUS:	Development production
RANGE:	10 miles
VELOCITY:	1860 mph
FRAME	
Manufacturer:	Douglas, Emerson Electric
Length (Overall), ft:	12
Diameter (Body), ft:	1
Span, ft:	2.5
Weight (Gross), lb:	980
Material (Major):	Steel and aluminum
GUIDANCE	
Type:	Unguided
POWER PLANT	
Manufacturer:	Allegheny Ballistics Lab.
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type: High explosive by Picatinny Arsenal	
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Rock Island Arsenal



Army

THE 12-FT. ***Little John*** **leaves its launching rail in short-range flight at White Sands.**

Army

EVEN THE SIMPLE free-flight ***Little John*** **requires an array of ground support gear.**

REDSTONE

The *Redstone* is a medium range (200-300 miles) liquid propellant powered ballistics missile. It recently entered operational service after many months of development testing. A modified version of the *Redstone, (Jupiter-C)*, was the power behind the launching of the United States' first satellite. Earlier models of the *Jupiter-C* were rigged as IRBM re-entry test vehicles.

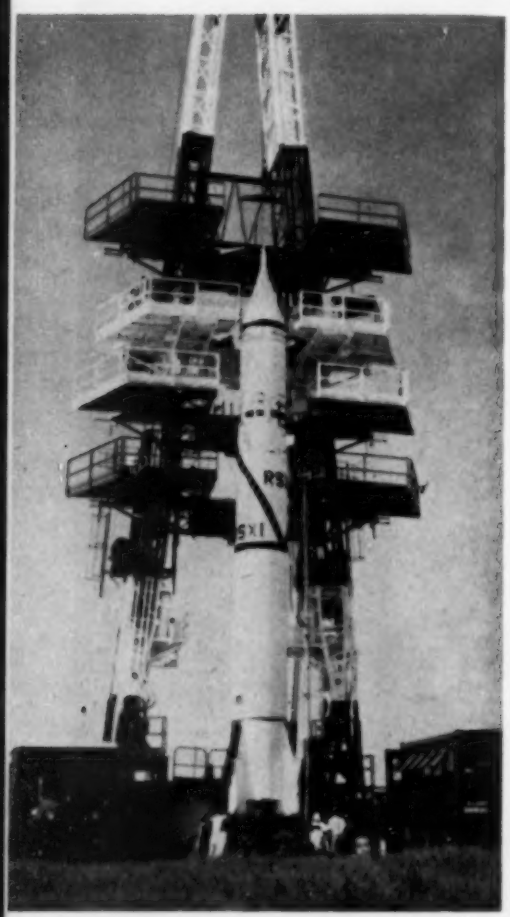
The missile is approximately 63 ft. long and 5 ft. 10 in. in diameter. Earlier prototypes varied in length from 62 to 69 ft. Major credit for the design and development of the *Redstone* belongs to the Wernher von Braun team of former German scientists at the Army's Ballistics Missile Agency. The team's experience with the famed V-2 rocket of World War II is clearly evident in many features of the *Redstone*.

Redstone is equipped with a liquid propellant rocket engine, developing 75,000-lb thrust burning liquid oxygen and alcohol. Graphite vanes located in the exhaust of the rocket supply thrust control. External fins provide aerodynamic stability, once sufficient velocity has been obtained.

Redstone's guidance system is entirely self-contained. The target data, or flight program, is fed into a program device, which plays back the information to the various elements of the control system that guide the missile in flight.

The missile has been designed so that it may be transported by air, rail or truck. It is later assembled and fired in the field. Production of the operational model of the *Redstone* is the responsibility of Chrysler.

DESIGNATION:	XSSM-A-14
PRIME CONTRACTOR:	Chrysler
STATUS:	Production, service use
RANGE:	180-250 miles
FRAME	
Manufacturer:	Reynolds Metal Co.
Length (Overall), ft:	62
Diameter (Body), ft:	5.5
Span, ft:	12
Weight (Gross), lb:	45,000
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Ford Instrument Co.
Type:	Inertial
POWER PLANT	
Manufacturer:	Rocketdyne
Propellants:	Liquid oxygen and alcohol
Type & Number:	Regenerative cooled (1)
Thrust, lb:	75,000
WARHEAD	
Type:	Nuclear capability (warhead separates)
GROUND SUPPORT MAJOR CONTRACTORS	
Fueling:	Air Products

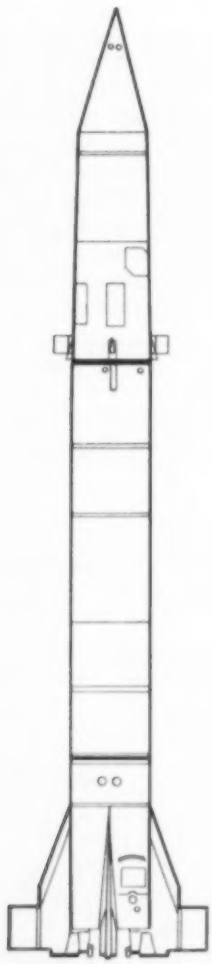


Army

REDSTONE **in the gantry for final checks.**

Army

FROST covers lower portion of *Redstone*.



SERGEANT

The *Sergeant* medium range guided missile is the latest addition to the Army's missile family. It will succeed the four-year-old *Corporal* and will incorporate improvements over the *Corporal's* power, range and accuracy.

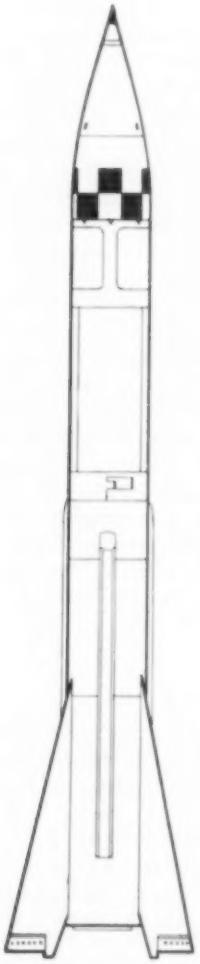
Sergeant's inertial guidance system is invulnerable to any known means of countermeasures. It uses a solid-propellant rocket, developed and produced by Tiokol Chemical Corp.

A highly mobile weapon, *Sergeant* can be quickly emplaced and fired under all weather conditions. The use of solid propellant and the inertial guidance have minimized system maintenance requirements and simplified ground handling procedures and equipment. The missile is launched in a near vertical position from an erector-launcher. All system elements have been designed for portability and mobility, and are transportable by air and standard Army vehicles.

The *Sergeant* system was designed and developed by the Jet Propulsion Lab of CIT. Production of the weapon system, including erector-launcher, servicing, handling and maintenance equipment, will be the responsibility of Sperry Rand Corp. Sperry received the prime contract for production of the missile system early in 1956. Production of the missile is currently underway at Sperry's Salt Lake City manufacturing facilities.

DESIGNATION:	FAGMS-S
PRIME CONTRACTOR:	JPL/Sperry Gyroscope
STATUS:	Development, production
RANGE:	100+

FRAME	
Manufacturer:	Sperry
Length (Overall), ft:	30
Diameter (Body), ft:	3
Span, ft:	7.7
Weight (Gross), lb:	20-25,000
Material (Major):	Aluminum and steel
GUIDANCE	
Manufacturer:	Sperry/Minneapolis-Honeywell
Type:	Inertial
POWER PLANT	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast Polysulfide (1)
Thrust, lb:	50,000+
WARHEAD	
Type:	Nuclear capability
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Sperry
Radar & Ground Control:	Sperry
Handling & Service:	GFE
Transport Vehicles:	GFE
Check Out Equipment:	Sperry



Army

Sergeant **ready to fire on launcher.**

Army

Corporal's **successor roars upward.**

U.S. ARMY

THE ARMY HAS demonstrated the tactical striking power of the helicopter, wedded to the rocket powered missile. This is an approach that will gain increasing favor with the Army and the Marine Corps. The helicopter also has proved its value in transporting tactical missiles from one site to another.

U.S. ARMY—Missiles of the Future

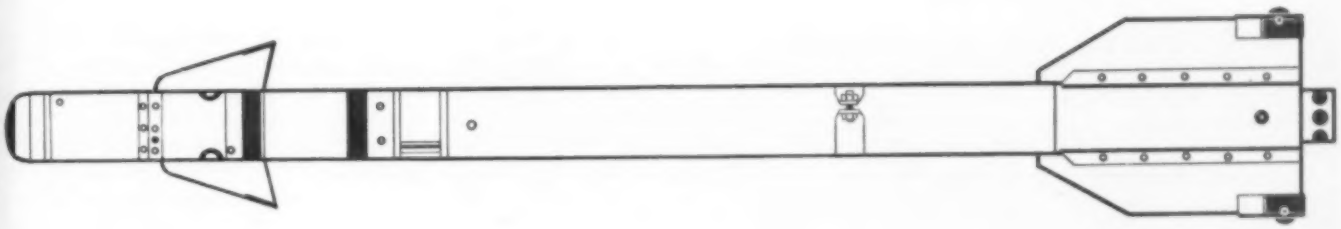
NIKE-ZEUS

Nike-Zeus is an anti-ballistic-missile missile system that can also be used against bombers. It has reached an advanced stage of development. One of the most critical factors has been detecting, which will utilize electromagnetic disturbances as the attacking missile re-enters and accelerates down through the atmosphere to impact. Overall system includes rocket-powered missile, electro-acoustical detection (for first warning), acquisition and missile trackering radar. Bell Telephone Laboratories has prime research and development responsibility; Western Electric, prime systems; Douglas, the missile. Over a quarter of a billion dollars of fiscal 1959 funds are allocated for *Nike-Zeus*.

PERSHING

Pershing is an over-500-mile range ballistic missile being developed for extended tactical surface-to-surface missions by the Army. It employs a nuclear warhead. While *Sergeant* replaces *Corporal* and *Redstone, Pershing,* in fact, extends the Army's range. Martin-Orlando has prime systems responsibility, while Thiokol will make the solid rocket propulsion system and Bendix, the guidance. The *Pershing* test vehicle will have a 30-ft. long by 2-ft. diameter first stage, with the second stage being somewhat shorter—like a stretched out but thinner *Polaris*. It will probably carry a one-megaton warhead. In terms of money, it is believed that Army has already scheduled about $1 billion for its development and initial production.

SIDEWINDER



The Navy's *Sidewinder* is a rugged, inexpensive, homing missile. It is capable of operating against high-performance aircraft, and can destroy enemy fighters or bombers from sea level to altitudes over 50,000 ft.

Sidewinder has less than two dozen moving parts, and no more electronic components than an ordinary radio. It does not need complex launching equipment, and is highly maneuverable at supersonic speeds. Specialized training is not required to handle and assemble the missile effectively.

The missile has a General Electric infra-red system and homes on radiation from its target. However, its performance is hindered by cloud formations due to the infra-red system. Basically designed as a defensive weapon for naval warfare, it will also be used in the air defense of the U.S.

The guidance system is passive infra-red, which usually takes the missile up the tail pipe of the target aircraft. The seeker occupies the first four inches of the missile, followed by the guidance section. The servo motors are located between the forward fins, followed by the warhead.

The missile is 4½ in. in diameter and 9 ft. long. The motor is 75 in. long, with a nozzle 7 in. in length.

Sidewinder's seeker is operative from the moment of the launcher aircraft's takeoff. Range at high altitude is 11,000 feet, and at sea level about 3,500 feet.

DESIGNATION:	AAM-N-7
PRIME CONTRACTOR:	Philco, GE
STATUS:	Production, service use
RANGE:	6-7 miles
VELOCITY:	Mach 2.5
FRAME	
Manufacturer:	Hunter-Douglas, Norris Thermador
Length (Overall), ft:	9.5
Diameter (Body), ft:	.42
Span, ft:	2
Weight (Gross), lb:	55
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Philco Corp.
Type:	Infra-red homing
POWER PLANT	
Manufacturer:	Hercules Powder
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Radar & Ground Control:	Philco
Handling & Service:	Beatrice Field Tank Co.
Check-Out Equipment:	Philco

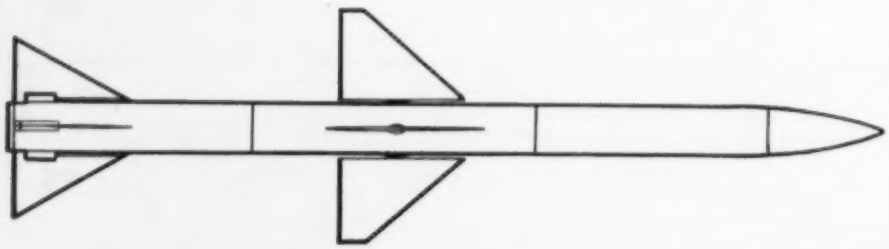
Navy

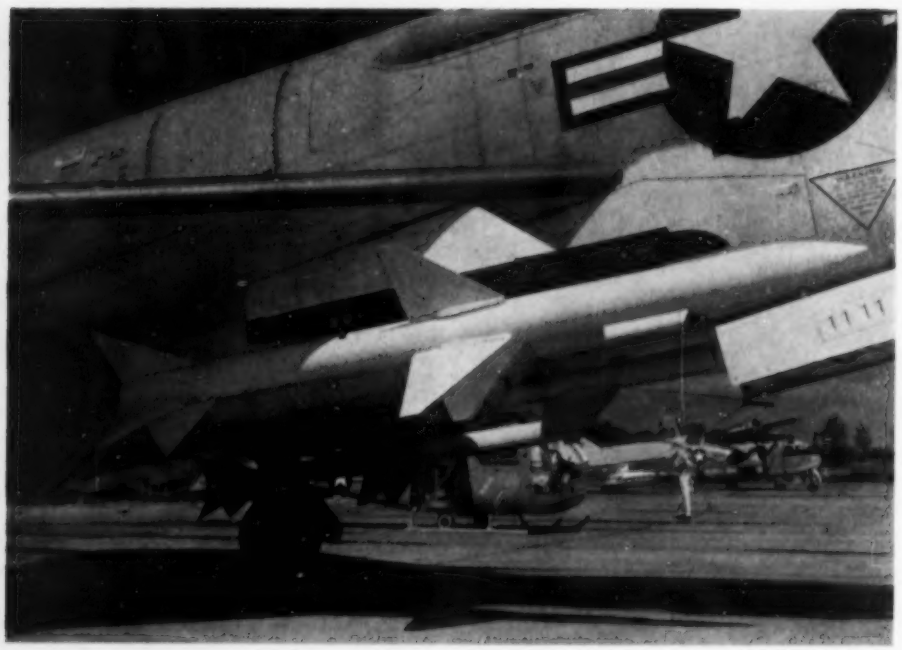
MODEL of the *Sidewinder* missile.

USAF

CHANGES in the most recent model.

SPARROW III





Howard Levy

ADVANCE OVER EARLY MODEL, missile attains immediate 1,000 mph speed.

Navy

MOST ADVANCED missile of kind is claim for *Sparrow* III.

Sparrow III was the first air-to-air guided missile in this country. The *Sparrow* I version, now obsolete, was developed by the Bureau of Aeronautics at the Naval Air Missile Test center and the Sperry Gyroscope Co.

The *Sparrow* I, and *Sparrow* III, are launched by carrier based fighters. The weapons system is versatile and permits effective attacks against high and low altitude targets flying alone or in groups.

Guidance signals deflect the wings of the missile, and direct interception to the objective, even under evasive action. Guidance is by radar homing, and is directed in the first seconds of flight by launching aircraft.

The Navy's *Sparrow* III is an advancement over *Sparrow* I. It attains a speed of over 1,000 mph immediately after launching. The Raytheon guidance system is said to be completely automatic in operation.

Sparrow III is the most advanced missile of its kind. It is intended to be used extensively by Navy fighter aircraft in Fleet air defense. *Sparrow* III is in the group of externally-slung, aircraft-launched missiles that are subject to temperature limitations which may limit the operational performance of their launching aircraft. The problem is aerodynamic heating, and the possibility of premature, explosive ignition of the propellant charge.

DESIGNATION:	AAM-N-6
PRIME CONTRACTOR:	Raytheon
STATUS:	Production
RANGE:	5-8 miles
VELOCITY:	Mach. 2.5-3
FRAME	
Manufacturer:	Raytheon
Length (Overall), ft:	12
Diameter (Body), ft:	.75 (approx.)
Span, ft:	3.25 (approx.)
Weight (Gross), lb:	350
Material (Major):	Aluminum and magnesium
GUIDANCE	
Manufacturer:	Raytheon
Type:	Radar homing
POWER PLANT	
Manufacturer:	Aerojet General
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Handling & Service:	Elgin National Watch Co.

ZUNI

The Navy's *Zuni* is an air-to-air rocket designed for fighter and attack-type aircraft. It is under development by the Naval Ordnance Test Station for the Bureau of Ordnance. *Zuni* has jet-operated folding fins, a feature that allows an aircraft to carry four times as many rockets.

Zuni will be effective against tanks, pillboxes and other hard-to-destroy emplacements. Its high velocity and short-time-to-target assures it as a high-kill potential in air-to-air combat. The launcher, mounted on the aircraft's wing, holds four rockets and is used for transporting and storing, as well as launching. Launchers are jettisoned after firing.

The *Zuni* carries a variety of warheads and fuse systems. It will be used for both air-to-air and air-to-surface firing.

The disadvantage of this type of weapon is that it is an aimed rocket rather than a guided missile. However, this concept has certain advantages, not the least of which is a minimum of "bugs"; it is simply constructed; can be produced and fired in volume at a low cost and to the limit of its abilities; is not only flexible as to operational deployment, but is available now. Even today, in the age of the highly complex guided (and therefore jammable) missile, it is a mainstay of weaponry.

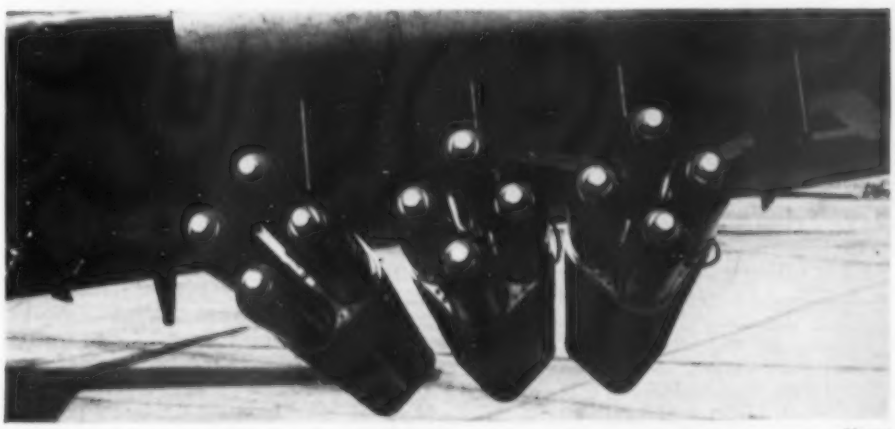
PRIME CONTRACTOR:	NOTS
STATUS:	Production
RANGE:	5 miles max.
VELOCITY:	Mach 3
FRAME	
Manufacturer:	Hunter-Douglas
Length (Overall), ft:	9.17
Diameter (Body), ft:	0.42
Weight (Gross), lb:	107
Material (Major):	Aluminum
GUIDANCE	
Type:	Unguided
POWER PLANT	
Propellants:	Solid
Type & Number:	Cast (1)—4 nozzles
WARHEAD	
Type:	High explosive

Navy

MISSILE is compact for easy carry on fighter aircraft.

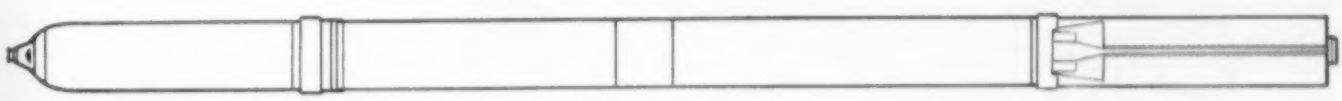
Navy

TANKS, PILLBOXES are among targets for *Zuni*.



Navy

FOLDING FINS make possible bigger load for plane.



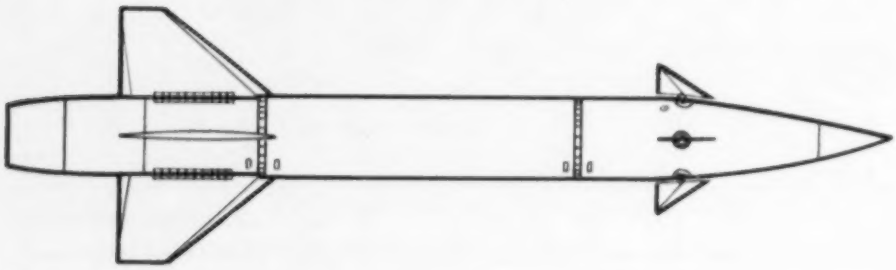
BULLPUP

Navy

BEING FITTED into wing holders, *Bullpup* shows size.

Navy

POWERFUL WEAPONS multiply armament of Navy plane.



The Navy's *Bullpup* is the first air-to-ground missile especially designed to provide non-nuclear fire support to ground troops and tactical targets. It is designed to practically eliminate the usual ground support system of maintenance and training.

Bullpup can carry a variety of 250 lbs. of bombs. It is a supersonic solid-propellant missile.

The missile is controlled by direction button in the cockpit of the firing aircraft. The control gives up-down and right-left commands. The pilot, by flying the aircraft, simultaneously flies the missile until it is zeroed-in on the target.

Because of the simplicity of the *Bullpup*, it can be checked out at the factory, placed in storage up to six months and have its three parts assembled and mounted on an aircraft in five minutes by a three-man crew. It has been said that this bird has "eyeball" guidance, but regardless of these witticisms, the *Bullpup* is one of the first of a long upcoming series of vitally important tactical missiles designed to minimize the roll of and danger to manned aircraft.

DESIGNATION:	ASM-N-7
PRIME CONTRACTOR:	Martin
STATUS:	Production
RANGE:	5 miles (approx.)
VELOCITY:	Mach 1-2
FRAME	
Manufacturer:	Martin
Length (Overall), ft:	11
Diameter (Body), ft:	1
Span, ft:	2.7 (approx.)
Weight (Gross), lb:	540
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Martin
Type:	Visual reference radio command
POWER PLANT	
Manufacturer:	Allegheny Ballistics
Propellants:	Solid
Type & Number	Cast, uncooled (1)
WARHEAD	
Type:	250-pound bombs

RAT

Rat is one of the Navy's rocket assisted torpedos. It is launched from destroyers in pursuit of enemy subs, and is expected to be in fleet operation by the end of this year.

Developed by the Naval Ordnance Test station, the *Rat* weapon system consists of standard homing torpedo, solid-propellant rocket booster and detachable aerodynamic control surfaces for stability.

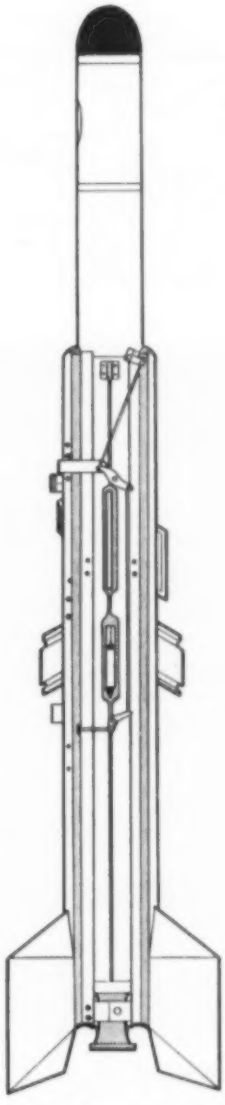
The destroyer's sonar equipment detects and tracks the enemy submarine. Then the ship's fire-control system elevates the *Rat* launcher and sets the range. The rocket motor propels the torpedo along a ballistic flight path and separates as it reenters the water where the parachutes and nose cape are discarded. *Rat* then starts a circling search pattern until the homing device makes contact and guides the weapon to its target.

The *Rat* may also be air launched.

Rat is the first of a long line of such anti-submarine weapons, such as *Subroc*, a more sophisticated follow-on.

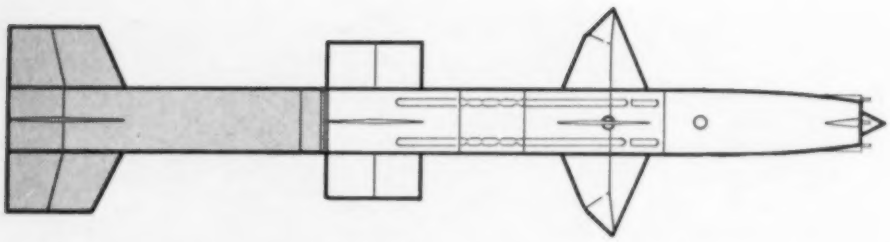
PRIME CONTRACTOR	NOTS
STATUS:	Production
RANGE:	5 miles

FRAME	
Stages:	2
Manufacturer:	NOTS
Length (Overall), ft:	16
Diameter (Body), ft:	1.28 (approx.)
Span, ft:	2.5 (approx.)
Weight (Gross), lb:	450
Material (Major):	Steel
GUIDANCE	
Manufacturer:	NOTS
Type:	Acoustical
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Allegheny Ballistics
Propellants:	Solid
Type & Number:	Cast, uncooled (1)
Second Stage	
Type & Number:	Homing Torpedo (1)
WARHEAD	
Type:	Standard Torpedo



MISSILE IS TORPEDO-LAUNCHED from destroyer at subs.

TALOS



Talos, a Navy supersonic guided missile, is designed to destroy enemy aircraft at a range of more than 65 miles and at extreme altitudes.

The *Talos* will form the major armament of the light cruiser Galveston, and plans are underway to equip the first nuclear-powered U.S. cruiser with the system.

The surface-to-air missile is accelerated to supersonic flight by a solid propellant rocket. The booster is jettisoned after the missile reaches cruising speed. The ram-jet sustainer then ignites, and provides thrust to keep the missile at a constant speed throughout its flight. A two-stage guidance system gives *Talos* the capability of high firepower, as well as accuracy at long ranges. The first stage carries the missile from launcher to target area; it is then taken over by a beam-riding guidance system.

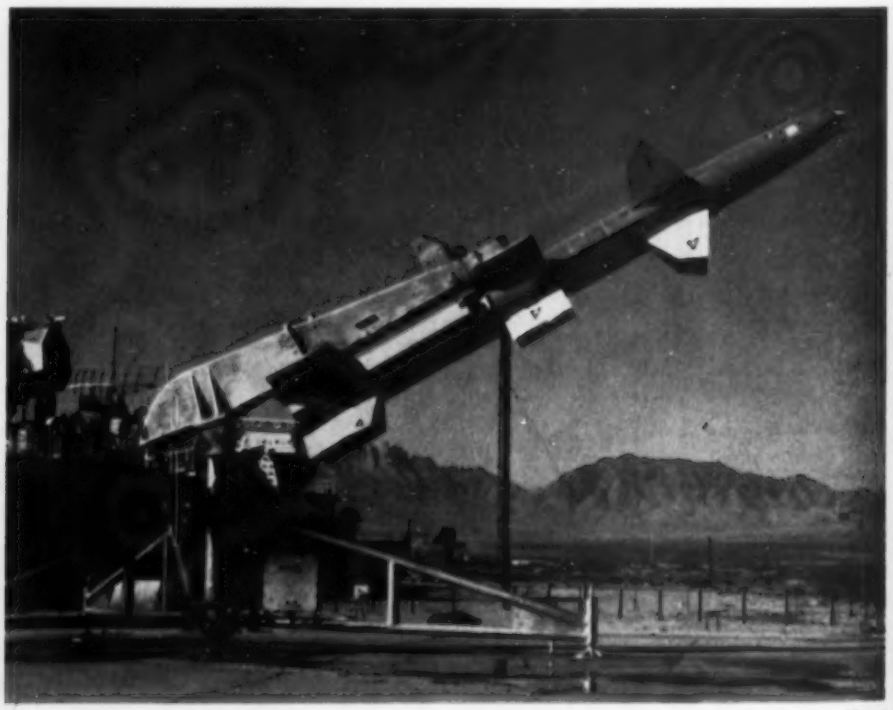
Talos is now being produced under a $27-million contract for the Navy by the missile section of the Bendix Aviation Corp. Its development began with the *Bumblebee* program, under the direction of the Applied Physics Lab of Johns Hopkins University.

By 1960, *Talos* will be installed aboard four other cruisers of the Navy, in addition to the Galveston. Army deployment of the *Talos* is still uncertain, although there are indications that it will be phased out before it becomes operational.

DESIGNATION:	SAM-N-6
PRIME CONTRACTOR:	Bendix, RCA
STATUS:	Production
RANGE:	70 miles (approx.)
VELOCITY:	Mach 3+
FRAME	
Manufacturer:	McDonnell
Length (Overall), ft:	20 (booster 10 ft. approx.)
Diameter (Body), ft:	2.5
Span, ft:	9.48
Weight (Gross), lb:	3000 (less booster)
Material (Major):	Steel
GUIDANCE	
Manufacturer:	Farnsworth Electronics, Sperry
Type:	Beam Rider/passive homing
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Bendix
Propellants:	Solid
Type & Number:	Cast (1)
Second Stage	
Manufacturer:	McDonnell
Propellants:	JP
Type & Number:	18" ramjet (1)
WARHEAD	
Type:	High explosive or nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	GE, RCA, American Machine & Foundry, North Ordnance
Radar & Ground Control:	RCA
Handling & Serv.:	GE, Northern Ordnance

Bendix

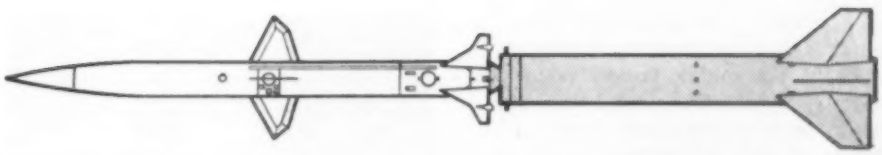
GALVESTON is first *Talos* cruiser.



Navy

***TALOS* AT LAND-BASED installation of the Naval Ordnance Missile Test Facility.**

TERRIER I & II



The Navy's *Terrier*, a supersonic surface-to-air missile, was fired experimentally in November, 1954, from the USS Mississippi. It is designed to intercept aircraft under all weather conditions at longer range and higher altitudes than anti-aircraft guns.

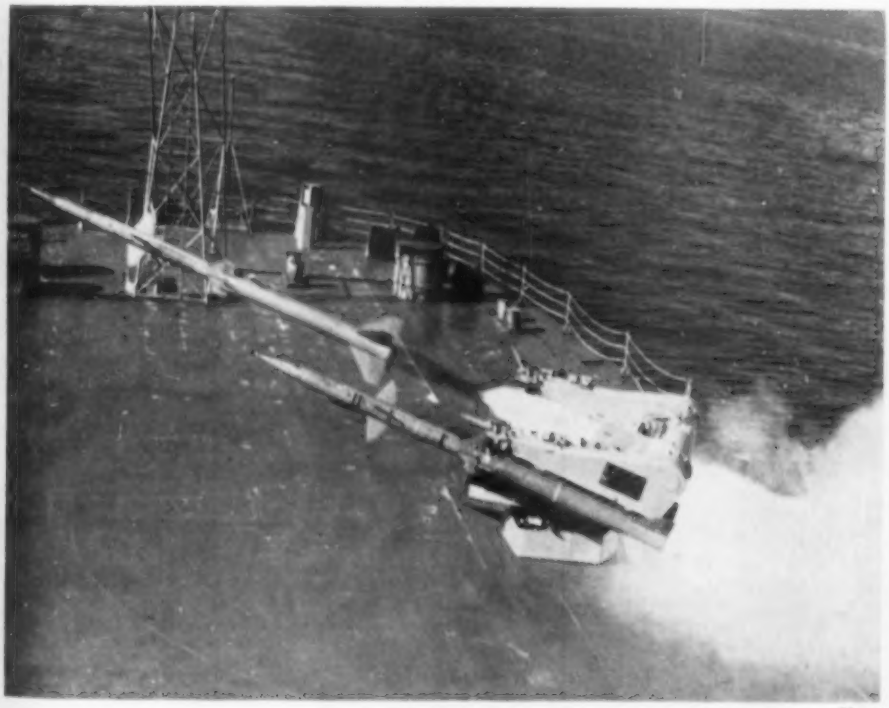
Terrier I is installed on the cruisers USS Boston, USS Canberra, destroyer USS Gyatt, and will be used on many other destroyer-frigate-type vessels. The solid-propellant power-plant is produced by Allegheny Ballistic. *Terrier* I is booster-launched, and travels to the target by beam-rider guidance.

Terrier II is reported to be larger than *Terrier* I, and will have radar homing guidance to supplement ship-board beam-rider direction. It will also be launched by a booster.

The *Terrier* is being produced in quantity for the U.S. Navy Bureau of Ordnance at the government-owned Naval Industrial Reserve Ordnance Plant, operated for the Navy by Convair.

Each *Terrier* launcher is served by its own magazine and missile over-haul and servicing room. The missiles and their boosters are stored vertically in a ready service ring, one for each arm of the two-missile launcher. The missile is selected, positioned, loaded and placed on its launching rail in a matter of seconds.

DESIGNATION:	SAM-N-7 (1)
PRIME CONTRACTOR:	Convair
STATUS:	Production, service use
RANGE:	10 miles max. (No. I), 20 miles max. (No. II)
VELOCITY:	Mach 2.5 max.
FRAME	
Stages:	2
Manufacturer:	Convair
Length (Overall), ft:	15 ft. (No. I), 27 with booster
Diameter (Body), ft:	1 (approx.)
Span, ft:	3.5 (approx.)
Weight (Gross), lb:	1000 launching wt. (No. I)
GUIDANCE	
Manufacturer:	Reeves/FTL (No. I) Sperry (No. II)
Type:	Beam rider
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Allegheny Ballistics The Hicks Co.
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
Second Stage	
Manufacturer:	Allegheny Ballistics
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Northern Ord.
Radar & Ground Control:	Sperry Gyro, Western Elec., Reeves Instr.
Handling & Service:	Baker-Raulang, Wash. Tech. Associates
Transport Vehicles:	Baker-Raulang



Navy

EARLY TEST VERSION of *Terrier* **leaving launcher aboard U.S.S. Norton Sound.**

Convair

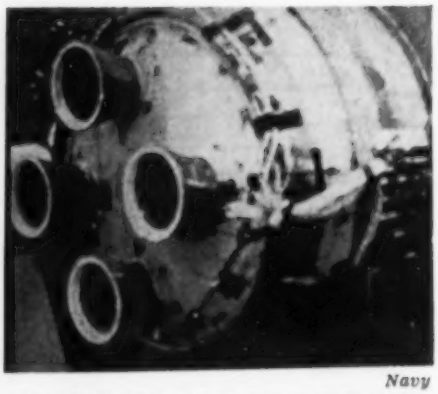
TERRIERS **ON AFT DECK of Canberra.**

POLARIS

The Navy first announced plans for the *Polaris* Fleet Ballistic Missile early in 1957. The missile is now rated "top priority" by the Navy, and will be the Navy's first intermediate range ballistic missile. *Polaris* is designed to fire from surface ships, as well as submarines in under-water positions.

Due to refinement of design, *Polaris* will be smaller and lighter than other IRBMs. It will be small enough to permit carrying a sizeable number of missiles in a single sub, without increasing the size beyond present nuclear powered submarine dimensions.

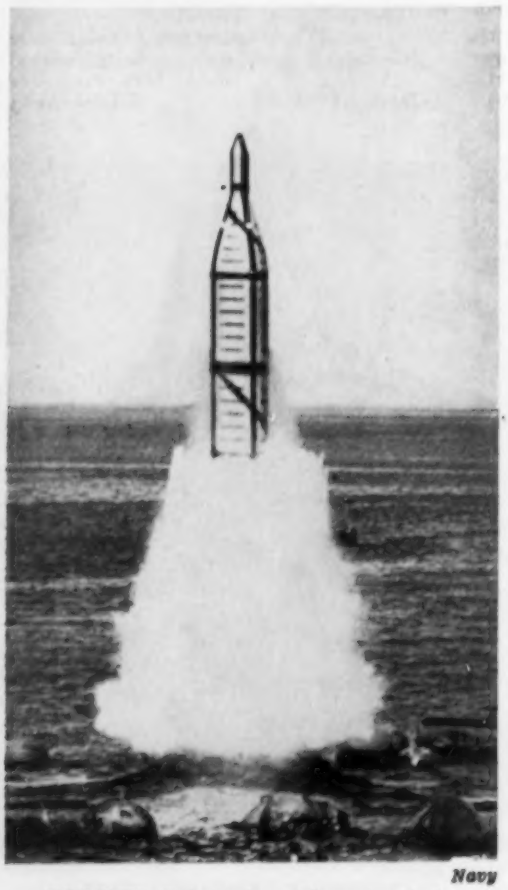
The missile is carried aboard the submarine in individual containers. Compressed air in the container forces the *Polaris* to the surface of the water in torpedo fashion. The missile will be lifted to altitude and set on course by its original propulsion and guidance components. *Polaris* is capable of carrying a thermonuclear warhead.



Navy

NOZZLE END of *Polaris* first-stage motor.

PRIME CONTRACTOR:	Lockheed
STATUS:	Research and development
RANGE:	1500 miles
VELOCITY:	6000 mph (average)
FRAME	
Stages:	2
Manufacturer:	Lockheed
Length (Overall), ft:	26.5
Diameter (Body), ft:	4.5
Weight (Gross), lb:	28,000
Material (Major):	Steel
GUIDANCE	
Manufacturer:	GE/MIT, Sperry Gyro
Type:	Inertial
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Aerojet
Propellants:	Solid
Type & Number:	(1) Cast, uncooled, 4 nozzles
Thrust, lb:	80-100,000
Second Stage	
Manufacturer:	Aerojet, Thiokol
Propellants:	Solid
Type & Number:	(1) Cast, uncooled, 3 nozzles, jetavators
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Westinghouse, Sperry Gyro
Fueling:	Aerojet
Radar & Ground Control:	G.E.
Handling & Service:	Westinghouse

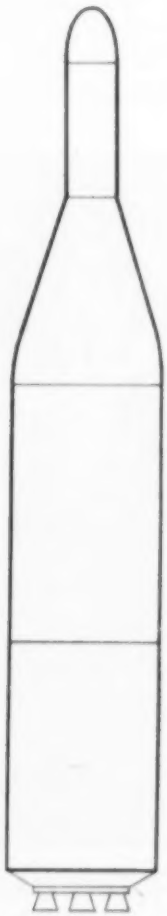


Navy

DUMMY *Polaris* in underwater tests.

Navy

EJECTION TESTS from simulated sub container.



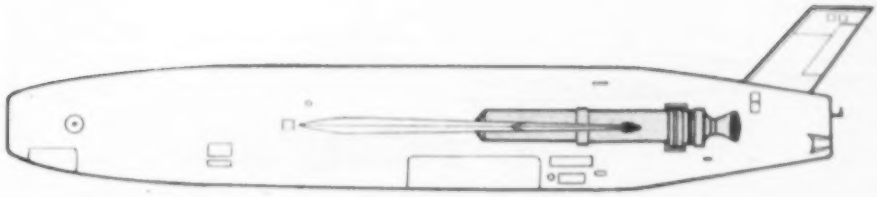
REGULUS I

Regulus I, surface-to-surface missile was developed by Chance Vought in 1948, under the sponsorship of the Bureau of Aeronautics. It resembles a swept-wing fighter. A submarine can surface, fire the *Regulus and* submerge, all within minutes. Tactically, it will be used by Marines against appropriate land targets.

Launching equipment can be installed in a short period of time on several types of vessels, with only slight modification to the ship. The missile's wings fold for shipboard storage.

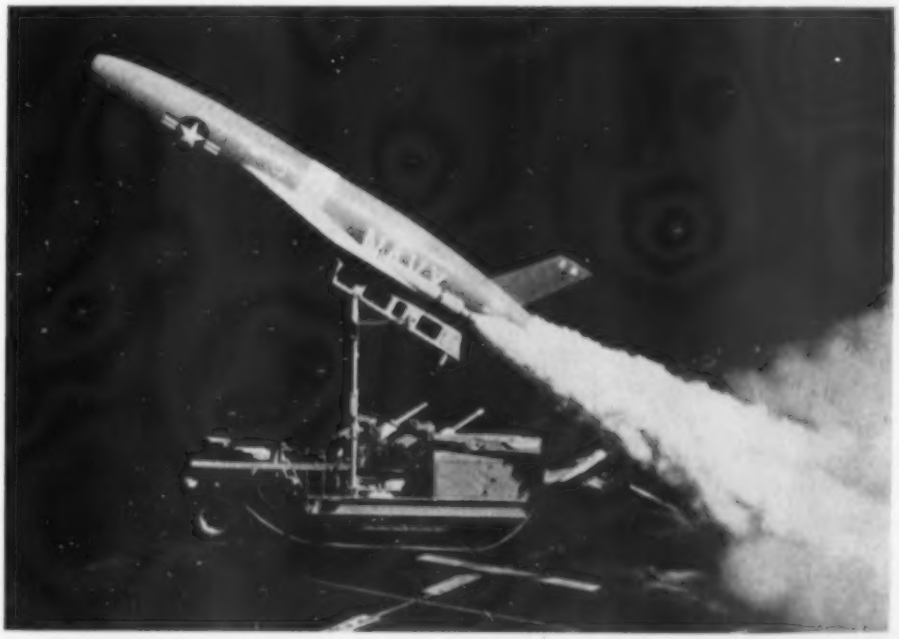
Regulus I is launched from a short rail launcher, where it rests on four slipper fittings. Launching boost is from two rockets which accelerate the *Regulus* to flying speed in a little over two seconds. Rocket cases and slippers are ejected after the launching. It is boosted to flight speed by two Aerojet solid propellant JATOs.

DESIGNATION:	SSM-N-8a
PRIME CONTRACTOR:	Chance Vought
STATUS:	Production, service use
RANGE:	500 miles
VELOCITY:	Mach 0.9
FRAME	
Manufacturer:	Chance Vought
Length (Overall), ft:	33
Diameter (Body), ft:	4.5
Span, ft:	21
Weight (Gross), lb:	12,000 (less booster)
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Sperry
Type:	Command
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Aerojet
Propellants:	Solid
Type and Number:	JATO (2)
Thrust, lb:	66,000 @ 33,000
Second Stage	
Manufacturer:	Allison
Propellants:	JP
Type & Number:	Turbojet (1)
Thrust, lb:	4600
WARHEAD	
Type:	High explosive or nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Fruehauf, Cook Electric
Fueling:	Bowser
Radar & Ground Control:	Chance Vought, Hallamore Electronics
Handling & Service:	Airlogistics, Weber, Fruehauf, AC Spark Plugs
Transport Vehicles:	Spencer-Stafford, Fruehauf



Navy

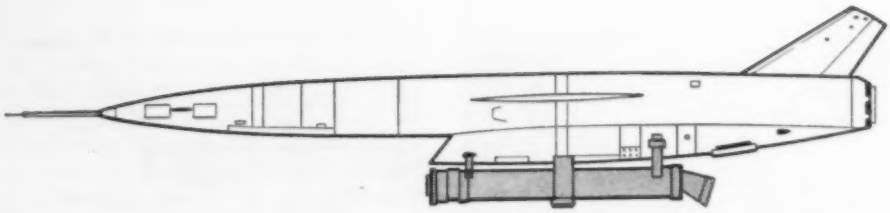
***REGULUS* CAN BE launched from carrier decks with steam catapulted carts.**



Navy

A ZERO-LENGTH launch is made from deck of carrier, boosted by rocket power.

REGULUS II



Navy

LANDING GEAR permits recovery of bird after flight.

Chance Vought

REGULUS **II has faster, longer range than predecessor.**

The Navy's faster-than-sound guided missile *Regulus* II, is a faster, longer-range version of *Regulus* I. *Regulus* II is designed to be launched from submarines, aircraft carriers cruisers and shore bases.

Chance Vought Aircraft reports that *Regulus* II is "probably the most remarkable 'Bird' now under development."

Regulus II has a General Electric turbojet J79 engine, and is capable of delivering a nuclear warhead with "pinpoint" accuracy to a target more than 1,000 miles away, at twice the speed of sound and at altitudes over 60,000 ft.

Test and training versions of *Regulus* II are equipped with landing gear so that the missiles can be recovered after each flight. *Regulus* II is a logical outgrowth of *Regulus* I, a subsonic, 1000-mile (with extra tanks) submarine-launched bird, now operational with the fleet.

DESIGNATION:	SSM-N-9a
PRIME CONTRACTOR:	Chance Vought
STATUS:	Development production
RANGE:	1000 miles
VELOCITY:	Mach 2
FRAME	
Manufacturer:	Chance Vought
Length (Overall), ft:	57
Diameter (Body), ft:	6
Span, ft:	20
Weight (Gross), lb:	22,000 (less booster)
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	AC Electronics
Type:	Command or inertial
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Aerojet
Propellants:	Solid
Type & Number:	JATO (1)
Thrust, lb:	100,000 (approx.)
Second Stage	
Manufacturer:	GE
Propellants:	JP
Type & Number::	J79 turbojet (1)
Thrust, lb:	15,000
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Fruehauf, Cook Electric
Fueling:	Bowser
Radar & Ground Control:	Chance Vought
Handling & Service:	Airlogistics, Weber, Fruehauf, AC Spark Plug
Transport Vehicles:	Spencer Stafford, Fruehauf

U.S. NAVY—Missiles of the Future

ASROC

Anti-Submarine Rocket, or—some say—Atomic-Submarine-Rocket. Launched underwater, the Asroc covers most of its distance through the air and then re-enters the water to seek its target by acoustical homing. Produced by the Minneapolis-Honeywell Co. which also has the systems responsibility.

ASTOR

Anti-Submarine Torpedo Ordnance Rocket. In development now by Westinghouse Ordnance, Baltimore, *Astor* is based on a vehicle the size of a Mark 18 torpedo. Nuclear warhead gives it a large kill radius when used as a supersubmarine killer. It is one of several such underwater atomic capabilities being developed by the Navy.

CORVUS

Corvus is an air-to-surface missile being developed by Temco under a multi-million dollar Navy contract. The missile would be used on carrier and shore-based aircraft of Navy and Marine Corps. Texas Instrument and W. L. Maxon are developing guidance, Reaction Motors reportedly is developing power plant.

CROSSBOW

Crossbow is an air-to-surface missile under development by Northrop, powered by a turbo-jet which will give it a velocity of about 500 knots. It homes on enemy radar. This makes it, in effect, an enemy defense degradation missile, designed to either silence or keep silent enemy radar.

DIAMONDBACK

Diamondback is an air-to-air missile believed to be a successor to the infra-red homing *Sidewinder*, and reportedly is under development by Naval Ordnance Test Station, China Lake, Calif. Basically, it will have increased range and performance over *Sidewinder* and Navy may fit it with "liquid-packaged" propellant. Philco is prime.

EAGLE

Still in the proposal and cross-proposal stage, the *Eagle* is rumored to be a "highly sophisticated" missile scheduled to be married to a simple fighter plane which will act only as a platform. Range is 50-100 miles and projected use is for both air-to-ground and air-to-air.

EX-8

EX-8 is an Aerojet-General project designed to give the Navy an ultra-high speed underwater anti-submarine missile. It is designated as a rocket (or perhaps hydro-duct) powered torpedo with speeds up to and perhaps exceeding 150 knots. Reportedly a new method of cavitation control has been developed to decrease drag and noise.

HOPI

Hopi is another Navy missile in the advanced development stage. Supposed to be capable of carrying a hydrogen warhead (minimum weight on the order of 650 pounds), *Hopi* is a medium-range air-to-surface missile being developed by the Naval Ordnance Test Station at Inyokern, Calif., designed for carrier aircraft.

KATIE

Katie, like *Subroc*, is a weapons system aimed at extending the useful life of conventional naval ships now in service. *Katie* is reported to be a rocket with a nuclear fission warhead that will be capable of utilizing regular 16-inch guns on Navy ships as launching tubes. Presumably it would be both surface-to-surface and anti-submarine.

RAVEN

An air-to-surface missile, one of many the Navy is currently working on. Unique feature is the hot-gas generator propulsion system. No other details have been revealed. However, it is rumored that this missile will also be launched by a comparatively simple fighter plane.

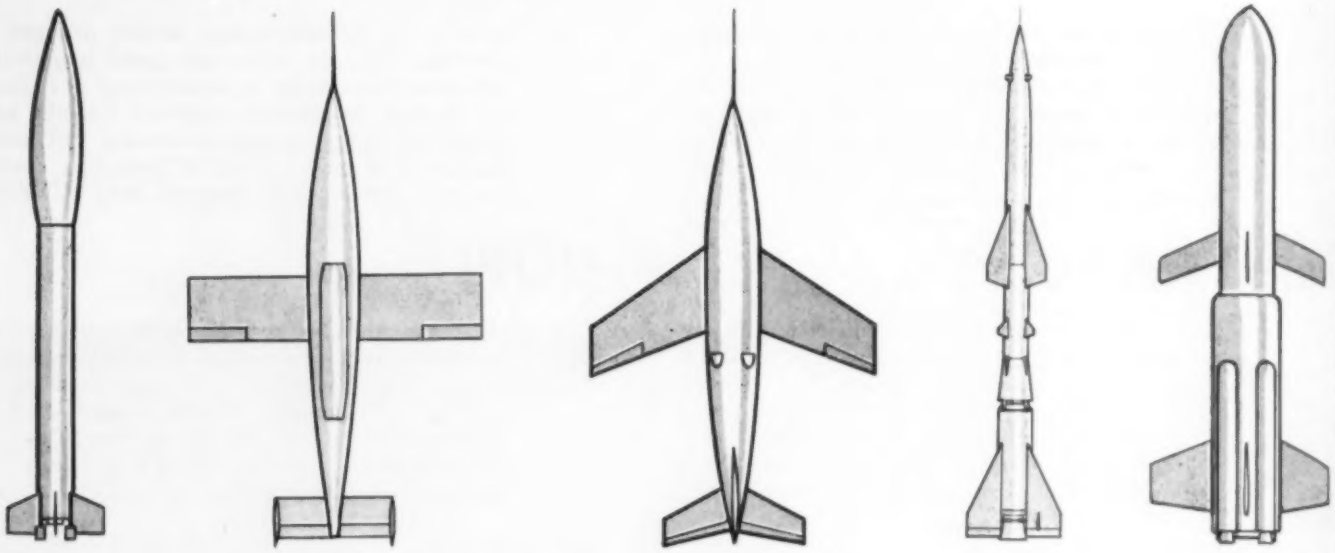
SUBROC

A missile designed to be launched from conventional torpedo tubes. Fired underwater, but flies most of its (25-50 mile) course through the air. Reported to have a nuclear capability. Goodyear is the prime contractor with Librascope and Kearfott companies listed as major sub-contractors.

TARTAR

Similar to the *Terrier*, but smaller, the *Tartar* is carried by cruisers and destroyers. After launch, the missile is a beam-rider. The radar beam can reportedly handle more than one missile at a time. Speed is in excess of Mach 2. Convair-Pomona has prime systems responsibility.

MISSILES of the U.S.S.R.



M-100A J-2 J-3 M-2 T-6

Air to Air

M-100A

The United States became familiar with the M-100A air-to-air missile during the conflict in Korea where it was first placed in service.

In the same class as the *Falcon*, this weapon is of a very primitive design. It features a single solid rocket, and can be used with infrared guidance or unguided.

STATUS:	Operational production
RANGE:	3.4 miles
VELOCITY:	1740 mph
FRAME	
Length (Overall), ft:	4.43
Diameter (Body), ft:	0.26
Span, ft:	0.82
Weight (Gross), lb:	18.5
GUIDANCE	
Type:	Infrared (also unguided.)
POWER PLANT	
Propellants:	Solid
Number	1
Thrust, lb:	100
Exhaust velocity:	1000 ft/sec.
Burning time:	3.1 sec.

Anti-Submarine

J-2

The J-2 air-breathing missile is similar to the *Snark*. Three versions of the missile are reported to be in the R&D stage.

In addition to its mission as a submarine weapon the J-2 can be equipped with containers to carry about 3,200 lbs. of supplies to isolated troop units.

The third J-2 version features landing skids for recovery purposes. The peak & ceiling is estimated at 6.8 miles.

STATUS:	Research and development
RANGE:	525 miles
VELOCITY:	645 mph
FRAME	
Stages:	2
Length (Overall), ft:	36.6
Span, ft:	23.6
Weight (Gross), lb:	16,100
GUIDANCE	
Type:	Radio
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Type & Number:	2
Second Stage	
Propellants:	Kerosene
Type & Number:	Axial-flow turbine (1)
Thrust, lb:	4850
WARHEAD	
Weight, lb:	2200

J-3

This weapon, designed for use against marine targets is a supersonic version of the J-2 and features the same fuselage and guidance instrumentation.

The main differences are the swept-back wings and the addition of a ramjet and two booster rockets. Being ramp-launched, the J-3 has a peak ceiling of 10.25 miles.

STATUS:	Trial production
RANGE:	450 miles
VELOCITY:	875 mph max.
FRAME	
Stages:	2
Length (Overall), ft:	38.25
Span, ft:	23.6
Weight (Gross), lb:	18,700
GUIDANCE	
Type:	Radio or radar
First Stage (Booster)	
Propellants:	Solid
Type & Number:	4
Second Stage	
Propellants:	Kerosene
Type & Number:	Axial-flow turbine and ramjet
Thrust, lb:	15,000
WARHEAD	
Weight, lb:	2200

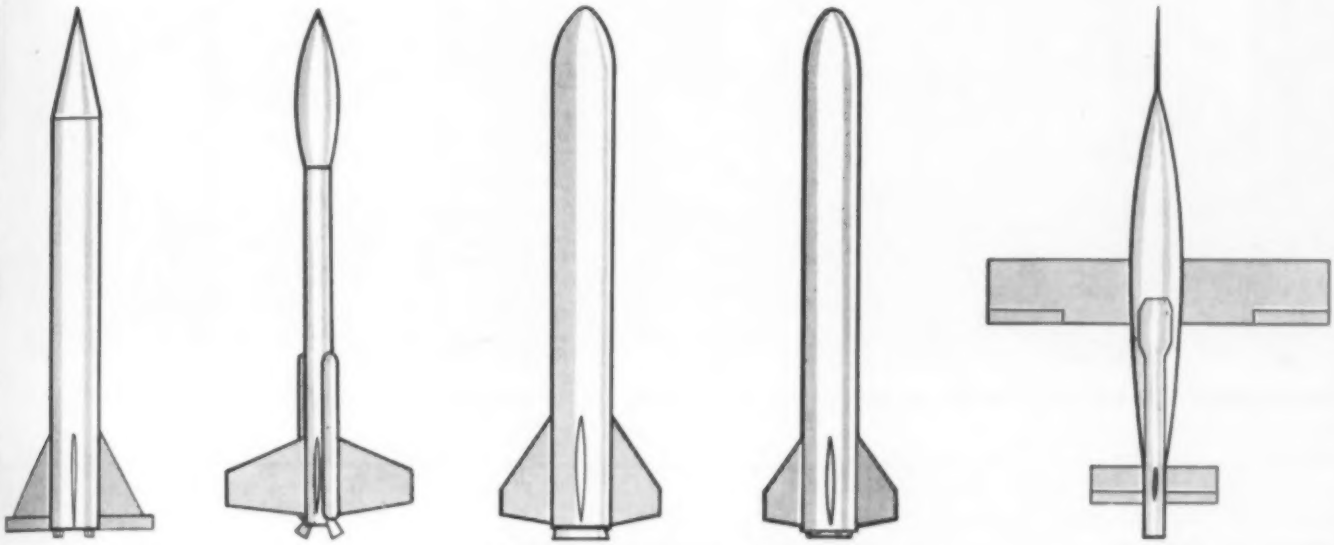
Surface to Air

M-2

The M-2 two-stage guided missile, intended for surface-to-air and surface-to-surface purposes, was developed from the German *Rheintochter*.

Already in service, this weapon is launched from mobile units.

STATUS:	Operational production



T-7 T-8 COMET 1 (CH-17) COMET 2 (CH-18) J-1

RANGE:	37.25 miles (Ceiling: 13.5-15.5 miles)
VELOCITY:	1550 mph
FRAME	
Stages:	2
Length (Overall), ft:	25
Diameter (Body), ft:	1.64
Span, ft:	9.9
Weight (Gross), lb:	3970
GUIDANCE	
Type:	Radar and infrared
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Number:	1
Thrust, lb:	9,350
Second Stage	
Propellants:	Solid
Number:	1
Thrust, lb:	4,625
WARHEAD	
Weight, lb:	22-26.5

T-6

A surface-to-air missile of the *Nike* class, this weapon is reputed to be highly efficient for air defense. It has four boosters in addition to the sustainer propulsion unit—and has an operational ceiling of about 60,000 feet. The high-explosive warhead is armed with a proximity fuze.

STATUS:	Operational
VELOCITY:	1630 mph
FRAME	
Stages:	2
Length (Overall), ft:	22
Diameter (Body), ft:	2.8
Span, ft:	7.9
Weight (Gross), lb:	4000
GUIDANCE	
Type:	Radar
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Number:	4
Thrust, lb:	10,000
Second Stage	
Propellants:	Solid
Number:	2
Thrust, lb:	1,100
WARHEAD	
Weight, lb:	88

T-7

The T-7 was originally developed by the USSR Academy of Sciences as a high altitude research vehicle, and has been adapted to military use. Its range is not available, but its peak altitude during flight is approximately 60 miles. Guidance is reported to be inertial.

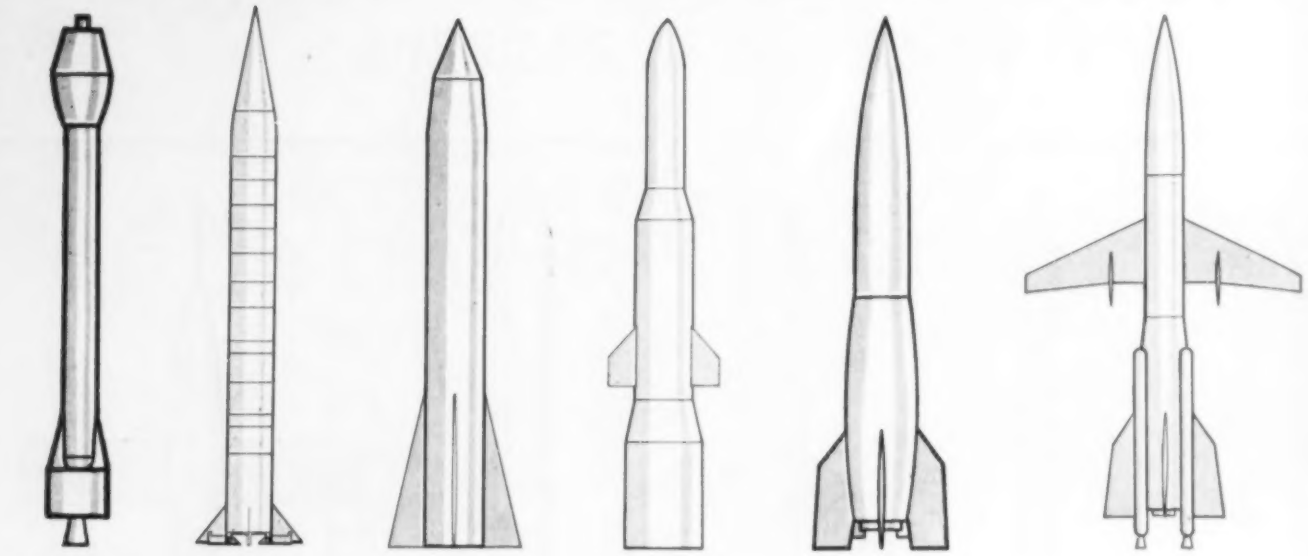
STATUS:	Operational
VELOCITY:	3350 mph
FRAME	
Length (Overall), ft:	30
Diameter (Body), ft:	2.7
Span, ft:	9.2
Weight (Gross), lb:	5,050
POWER PLANT	
Propellants:	Liquid oxygen and hydrazine
Type & Number:	LPR
Thrust, lb:	11,000
WARHEAD	
Weight, lb:	18

T-8

The best anti-aircraft missile in the Soviet Union, this infrared-guided missile is a single-stage vehicle utilizing boosters for initial acceleration. The missile is highly maneuverable in the air and highly mobile on the ground, being used by field batteries from non-permanent positions. Its high-explosive warhead is armed with a proximity fuze.

The T-8 has been in use for several years and is used in the defense of most Soviet cities. Other rockets in this category are the T-6 and the GVAI, both being rough counterparts of the *Nike-Ajax* surface-to-air missile.

STATUS:	Operational
RANGE:	15 miles
VELOCITY:	1450 mph
FRAME	
Stages:	2
Length (Overall), ft:	13.2
Diameter (Body), ft:	1.05
Span, ft:	4.8
Weight (Gross), lb:	1875
GUIDANCE	
Type:	Infrared
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Number:	2
Second Stage	
Propellants:	Nitric acid/alcohol
Number:	1
Thrust, lb:	4600
WARHEAD	
Weight, lb:	4.9



ME (IGOR) T-1 (M-101) T-2 (M-103) T-3 (M-104) T-4 (M-102) T-4A

Surface to Surface

COMET 1 (CH-17)

Originally designed as a research vehicle for studies of the *Comet* 2 re-entry problem, *Comet* 1 performed so well that it was put in production and subsequently placed in service.

This single-stage, solid-propellant missile has a burning time of 18 sec., a maximum ceiling of about 42 miles, and a thrust-to-weight ratio of 2.63.

STATUS:	Operational production
RANGE:	75-100 miles
VELOCITY:	3225 mph.
FRAME	
Length (Overall), ft:	36.8
Diameter (Body), ft:	4.26
Span, ft:	10.9
Weight (Gross), lb:	20,000
POWER PLANT	
Propellants:	Solid
Thrust, lb:	53,250
Exhaust Velocity:	9200 ft/sec
WARHEAD	
Weight, lb:	460

COMET 2 (CH-18)

This missile's exterior is in general identical to that of *Comet* 1. The only apparent difference is in the longer cone of *Comet* 2 due to the larger warhead.

With a thrust-to-weight ratio of 2.4 *Comet* 2 reaches peak height at 195 miles. The power plant is a solid propellant version of the German A-9 with a burning time of 115 sec.

It has been reported that the USSR has a production of approximately 3200 *Comet* 2 missiles per month.

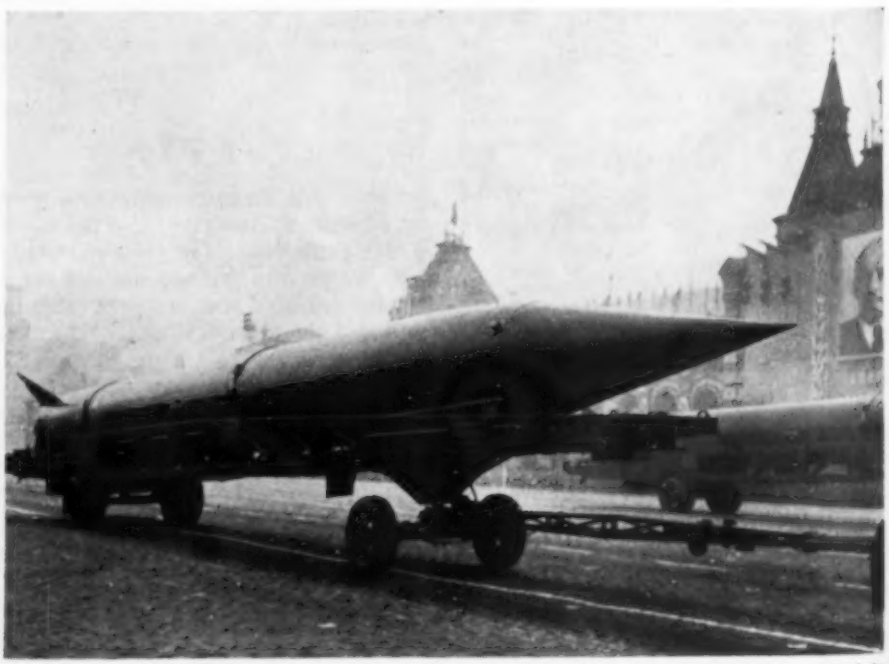
STATUS:	Production; being readied for service.
RANGE:	620 miles
VELOCITY:	5700 mph
FRAME	
Length (Overall), ft:	43.4
Diameter (Body), ft:	4.26
Span, ft:	10.9
Weight (Gross), lb:	41,500
GUIDANCE	
Type:	Inertial
POWER PLANT	
Propellants:	Solid
Thrust, lb:	99,000
Exhaust velocity:	9500 ft/sec
WARHEAD	
Weight, lbs:	550

J-1

The J-1 medium-distance, low-level, guided attack weapon is to a large degree a continuation of the German V-1.

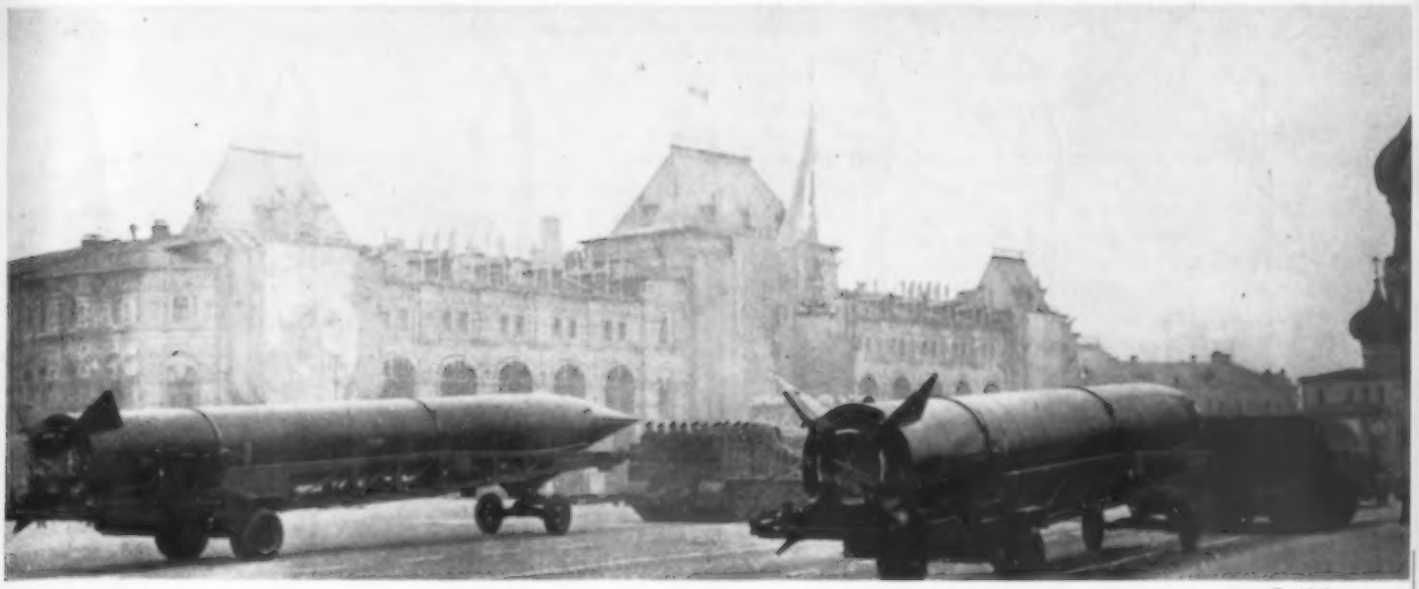
It can be launched from either runway or sled and has a peak ceiling of approximately 4 miles. Low-level flight is made possible through equipment within the missile designed to cut out detection radar.

STATUS:	Operational production
RANGE:	370 miles



Sovfoto

THE SOVIET T-1, AN IMPROVED GERMAN V-2, mainstay of the SSM program.



Sovfoto

GRAPHITE VANES JUTTING INTO THE EXHAUST STREAM of the T-1 indicate technique of gimballed motors not used.

VELOCITY:	519 mph
FRAME	
Length (Overall), ft:	26.9
Span, ft:	20.7
Weight (Gross), lb:	9700
GUIDANCE	
Type:	Radio
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Number:	2
Second Stage	
Propellants:	Kerosene
Type & Number:	Pulsejet (1)
Thrust, lb:	2000
WARHEAD	
Weight, lb:	2640

ME (IGOR)

This anti-tank missile is to a certain degree comparable to the U.S. *Bazooka*, and it uses the same type launching system.

The ME, however, has a longer range, but it is doubtful whether this is of significance in anti-tank warfare. It is difficult to make a hit with a *Bazooka* at distances above 900-1000 ft.

STATUS:	Operational production
RANGE:	2.25 miles
RANGE:	
VELOCITY:	535 mph
FRAME	
Length (Overall), ft:	4
Diameter (Body), ft:	0.41
Weight (Gross), lb:	10.5
POWER PLANT	
First Stage	
Propellants:	Solid
Type & Number:	Sulphur-base 1
Thrust, lb:	61.5
Exhaust velocity:	9250 ft/sec.
Burning time:	3 sec.
WARHEAD	
Weight, lb:	3.75

T-1 (M-101)

An almost-exact copy of the German V-2 (A-4) missile, this vehicle has a greatly increased range due to structural and fuel improvements. The T-1 is as mobile as our *Redstone*, and is equipped with a self-propelled launcher and support vehicles. The T-1 configuration follows a straight cylinder design, whereas the V-2 was more elliptical. The change is due to the easier production of the cylinder sections. This missile is the basic design from which the longer range T-2 was developed, and is reported to be the third stage of the intercontinental T-3. There is considerable conjecture that *Sputnik* II consisted of an entire T-1 rocket placed in orbit, but contradictory evidence prevents any conclusion on this speculation.

STATUS:	Operational
RANGE:	400-600 miles
VELOCITY:	4400 mph
FRAME	
Length (Overall), ft:	50-52 ft
Diameter (Body), ft:	5.15
Span, ft:	12
Weight (Gross), lb:	38,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANT	
Propellants:	Oxygen/alcohol
Thrust, lb:	77,000-78,000
WARHEAD	
Weight, lb:	2,650
Type:	Nuclear

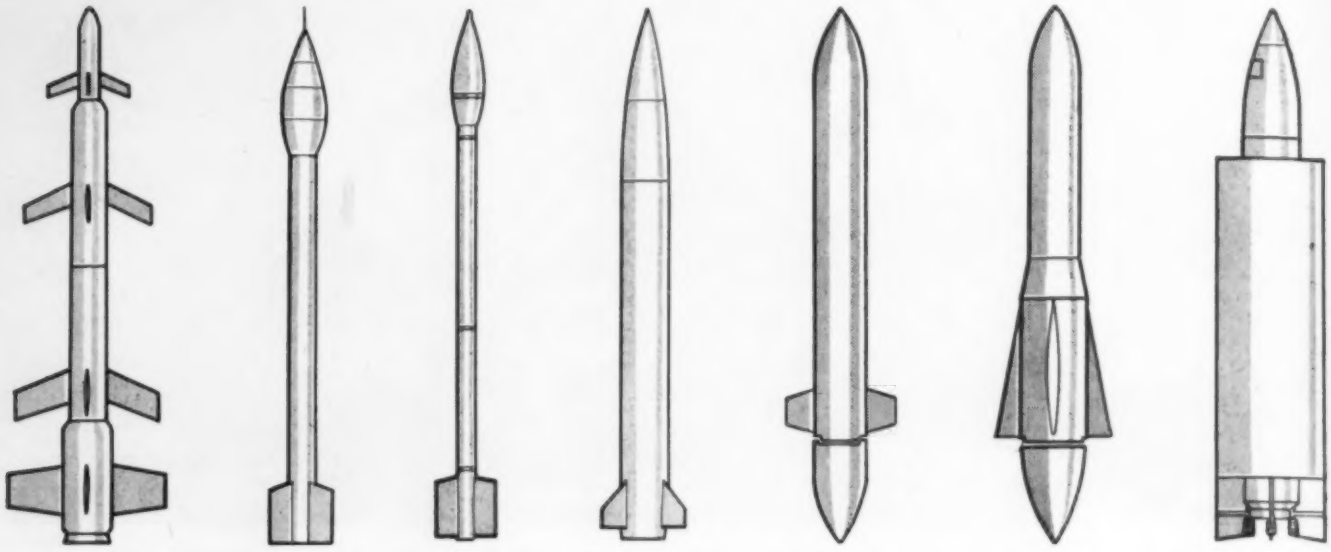
T-2 (M-103)

The most operational of Soviet long-range missiles, the T-2 is the first two-stage missile in the USSR's arsenal. It has been deployed throughout Europe at various bases, and reportedly has been concentrated along the southern flank of the satellite countries in order to cover the U.S. airbases in North Africa and Spain where SAC operates. Other T-2 launching sites are located so as to reach most of western Europe. There is little doubt that this missile is a continuation of the T-1 program, which sprang from the German V-2 missile and was greatly improved upon by the Russians.

STATUS:	Operational
RANGE:	1800 miles
VELOCITY:	5200 mph
FRAME	
Stages:	2
Length (Overall), ft:	90-100
Diameter (Body), ft:	12-15
Span, ft:	27
Weight (Gross), lb:	122,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANTS	
First Stage (Booster)	
Propellants:	Oxygen/alcohol
Thrust, lb:	254,000-270,000
Second Stage	
Propellants:	Oxygen/alcohol
Thrust, lb:	77,000-78,000
WARHEAD	
Weight, lb:	2450
Type:	Nuclear

T-3 (M-104)

This missile was first reported successfully fired in August, 1957. Also designated M-104, the missile has a reported accuracy of ±10 miles from a given point. The second and third stages are understood to be modified



T-1 and T-2 missiles, thus simplifying development programs and allowing the maximum mileage from a minimum of hardware and logistical support items. The T-3 is probably the Soviet missile showing the least German influence on its design.

It has a good mass ratio, and is adaptable to mass production without the setting up of a complex system of precision operations. Guidance is in the second stage. The missile is quite likely to be the basic unit for the satellite-launching vehicle utilized by the USSR.

STATUS:	Development production
RANGE:	5000 miles
VELOCITY:	15,000 mph
FRAME	
Stages:	3
Length (Overall), ft:	110-125
Diameter (Body), ft:	16
Span, ft:	23.5
Weight (Gross), lb:	165,000-175,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANTS	
First Stage	
Propellants:	Oxygen/kerosene
Number:	1-2
Thrust, lb:	490,000-500,000
Second Stage	
Propellants:	Oxygen/kerosene
Number:	
Thrust, lb:	270,000
WARHEAD	
Weight, lb:	2200
Type:	Nuclear

T-3A

A follow-on program of the T-3, this missile has an increased range but decreased payload capability. Two versions of the T-3A have been reported.

STATUS:	Development production
RANGE:	6200 miles
VELOCITY:	16,000 mph
FRAME	
Stages:	3
Length (Overall), ft:	112
Diameter (Body), ft:	16
Span, ft:	23.5
Weight (Gross), lb:	185,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANTS	
First Stage	
Propellants:	Liquid oxygen/kerosene
Number:	1-2
Thrust, lb:	520,000
Second Stage	
Propellants:	Liquid oxygen/kerosene
Number:	1
Thrust, lb:	270,000
WARHEAD	
Weight, lb:	1200 (approx.)
Type:	Nuclear

T-4 (M-102)

This medium range ballistic missile is reported to have excellent guidance, but at the sake of high efficiency levels for the overall vehicle. It will deliver an 1,800-pound atomic warhead to a target with great accuracy, and can be fired from relatively mobile field equipment—as our *Redstone* or the German V-2 missiles.

STATUS:	Production
RANGE:	1000 miles
VELOCITY:	9500 mph
FRAME	
Stages:	2
Length (Overall), ft:	50-55
Diameter (Body), ft:	6.6
Span, ft:	14
Weight (Gross), lb:	71,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANTS	
First Stage (Booster)	
Propellants:	Oxygen/hydrazine
Number:	1
Thrust, lb:	182,000
Second Stage	
Propellants:	Oxygen/hydrazine
Number:	1
Thrust, lb:	53,000
WARHEAD	
Weight, lb:	1775
Type:	Nuclear

T-4A

This is a Soviet version of the Saenger-Bredt antipodal boost-glide skip bomber, and its presence in the Soviet arsenal prompted the U.S. to launch the Dyna-Soar project. It will quite likely be a manned vehicle, but some sources have disputed this. Stainless steel surfaces will reduce air friction and heating. A free-fall bomb or a guided missile may be utilized as armament.

After completion of a mission, the pilot may land the vehicle in the ocean and be picked up by a submarine; or, range permitting, may land in friendly territory. The idea behind this type of vehicle was first proposed as far back as the early days of World War II, but met with scepticism and was not adopted.

STATUS:	Development, preliminary testing
RANGE:	12,000 miles
VELOCITY:	14,000-15,000 mph
FRAME	
Length (Overall), ft:	120-125
Diameter (Body), ft:	10-12
Span, ft:	63.5
Weight (Gross), lb:	232,000

GUIDANCE
Type: Manned aircraft
WARHEAD
Weight, lb: 3100
Type: Nuclear

T-5

A three-stage unguided missile with a range of about 100 miles, this is essentially a copy of the German Rheinbote design. It has been supplied to East European satellite armies and is mobile—as are a great many Soviet missiles. The missile is supplied to batteries which have six launchers each. Accuracy of the missile is believed to be quite good, but the type of warhead is unknown. Considering the gross weight of less than 5,000 pounds, a nuclear warhead seems unlikely, but possible.

STATUS: Operational
RANGE: 100 miles
VELOCITY: 2900 mph
FRAME
Stages: 4
Length (Overall), ft: 32.2
Diameter (Body), ft: 2.9
Span, ft: 9.4
Weight (Gross), lb: 4850
GUIDANCE
Type: Unguided
POWER PLANT
Propellants: Nitric acid/hydrazine (booster); SPR's (main propulsion)
Thrust, lb: 1) 83,500; 2) Unguided 3) 2,300; 4) 440

T-5B

This weapon is carried on a self-propelled launcher—a KW 85 or a Joseph Stalin II AFV tank chassis. The missile is protected during cold weather operations by a wrap-around clamshell-type heater to keep the propellant warm. According to some reports, the rocket can be elevated to firing position, alignment adjustments made, and the missile fired without a crew member leaving the armored carrier-vehicle.

STATUS: Operational
RANGE: 25
FRAME
Length (Overall), ft: 30
Diameter (Body), ft: 2.5
GUIDANCE
Type: Unguided

T-5C

This is a smaller version of the T-5B, apparently using less-temperature-sensitive propellant since the carrier vehicle is not equipped with protective heaters for the missile. It is not known whether this is a scaled-down T-5B, or whether advances in propulsion and warheads have allowed a reduction in overall size. Photos indicate that the missile is carried by a Type 1955 reconnaissance AFV chassis believed to be fully amphibious and providing full protection for the crew.

STATUS: Operational
RANGE: 15-20 miles
FRAME
Length (Overall), ft: 25
Diameter (Body), ft: 1-1.5 ft. (approx.)
Span, ft: 2.5-3 ft. (approx.)
Weight (Gross), lb: 4,400
GUIDANCE
Type:
POWER PLANT
Propellants: Solid
Number: 1
Thrust, lb:
WARHEAD
Weight, lb: 1100
Type: High explosive or nuclear

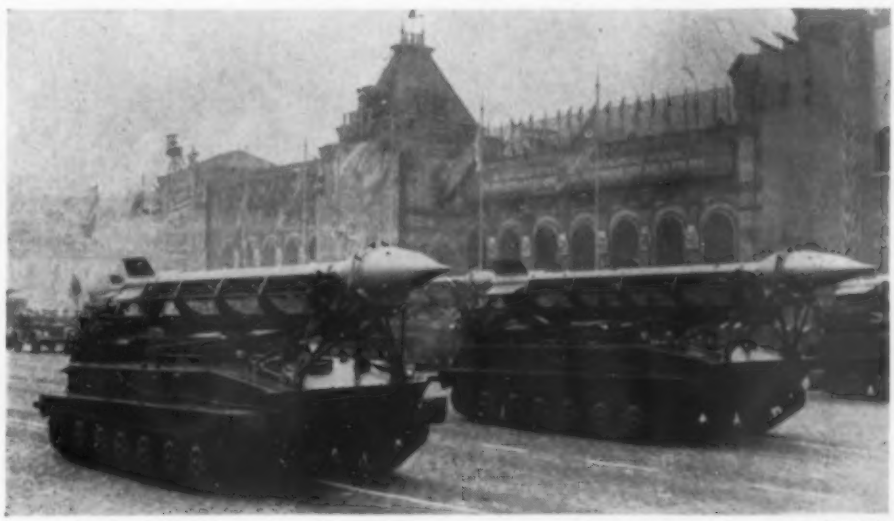
T-7A

A modification of the T-7, this later version is rapidly replacing the T-5, which is now obsolescent and has been placed in the hands of the East European satellites. The T-7A has the same range as the T-5—100 miles—but is more accurate and utilizes a radio-inertial guidance system. It is not known whether the USSR has succeeded in equipping this missile and the T-5 with nuclear warheads. It is supported by mobile launching equipment and may be used in the field from non-permanent installations, as was the V-2.

STATUS: Operational
RANGE: 100 miles
VELOCITY: 3200 mph
FRAME
Length (Overall), ft: 27.8
Diameter (Body), ft: 2.7
Span, ft: 9.6

Sovfoto

HONEST JOHN'S COUNTERPART IS THE T-5B, an unguided rocket on a tracked tank chassis.



Sovfoto

A SMALLER VERSION IS THE T-5C, also on a tracked chassis, but lighter.

Weight (Gross), lb:	4,500
GUIDANCE	
Type:	Radio-inertial
POWER PLANT	
Propellants:	Liquid oxygen and hydrazine
Number:	1
Thrust, lb:	11,500
WARHEAD	
Weight, lb:	177

Underwater to Surface

GOLEM-1

The *Golem*-1 underwater-to-surface missile is transported in tow by submarines. On arrival at launching site, a chamber at the tail of the missile is filled with water to insure vertical positioning. This chamber breaks away shortly after the missile emerges from the water and is in flight.

Peak ceiling is 142 miles. It is assumed that a large number of the USSR submarine-fleet, which includes more than 600 vessels, is rigged to handle the *Golem*-1. The missile is capable of carrying an atomic warhead.

STATUS:	Operational production
RANGE:	400 miles
VELOCITY:	5425 mph
FRAME	
Length (Overall), ft:	54
Diameter (Body), ft:	5.41
Span, ft:	11.1
Weight (Gross), lb:	33,125
GUIDANCE	
Type:	Radio-inertial
POWER PLANT	
Propellants:	Liquid oxygen and alcohol
Type & Number:	1
Thrust, lb:	121,200
Exhaust velocity:	8000 ft/sec.
Burning time:	65 sec.
WARHEAD	
Weight, lb:	1750-2000

GOLEM-2

The *Golem*-2, which is reported to be the underwater version of the T-2 IRBM, is still in the R&D stage.

The major difference is in the propellant used for both stages, i.e., *Golem*-2 uses a nitric acid-alcohol combination, while T-2 is propelled by liquid oxygen and alcohol. It is assumed that this change was incorporated for the purpose of increasing the storage capacity of the underwater version. Peak ceiling is 244 miles.

STATUS:	Research and development
RANGE:	1240 miles
VELOCITY:	9325 mph
FRAME	
Stages:	2
Length (Overall), ft:	57
Diameter (Body), ft:	7.2
Span, ft:	13.1
Weight (Gross), lb:	75,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANTS	
First Stage (Booster)	
Propellants:	Nitric acid and alcohol
Thrust, lb:	242,000
Second Stage	
Propellants:	Nitric acid and alcohol
Thrust, lb:	71,500
Total burning time:	185 sec.
Exhaust velocity:	10350 ft/sec.
WARHEAD	
Weight, lb:	1430

Underwater to Air

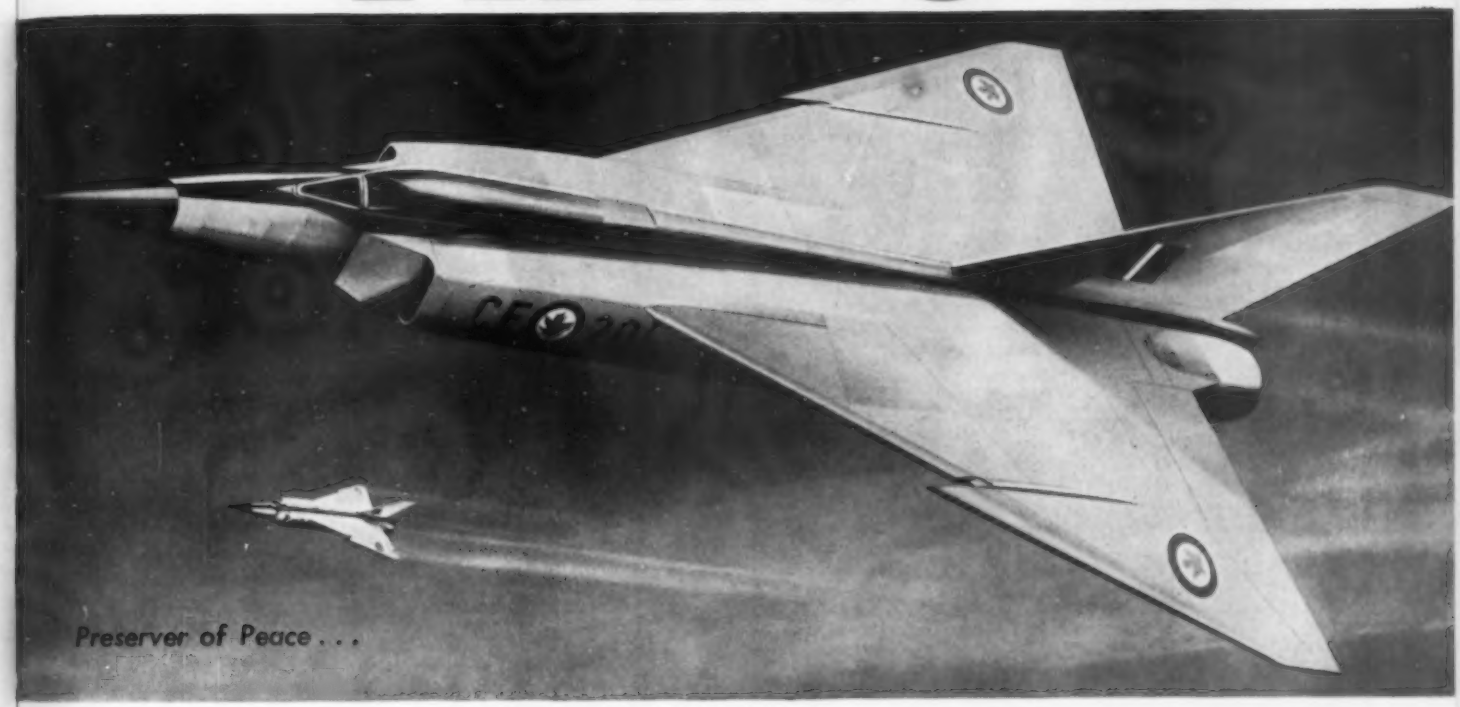
GOLEM-3

The *Golem*-3 is a solid propellant anti-aircraft missile designed to be launched from either a submarine or a mobile battery. Reportedly, this weapon can be launched from depths of approximately 650 ft.

STATUS:	Operational production
RANGE:	7.45 miles
VELOCITY:	1860 mph
FRAME	
Length (Overall), ft:	17.1
Diameter (Body), ft:	2.14
Span, ft:	5.9
Weight (Gross), lb:	4625
GUIDANCE	
Type:	Infrared
POWER PLANT	
Propellants:	Solid
Type & Number:	4
Thrust, lb:	15,000
Exhaust velocity:	10,000 ft/sec.
Burning time:	8.2 sec.
WARHEAD	
Weight, lb:	175

THE ØVERRIDING CHARACTERISTIC OF MOBILITY is shown in every photo of Soviet missiles, as demonstrated by the T-7A.

AVRO ARROW



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Every advance in aircraft engineering is exemplified in the Avro Arrow, capable of traveling at well over twice the speed of sound to intercept and destroy enemy aircraft at extremely high altitudes. RCA has been assigned full responsibility for the development of a complete electronic system for fire control, navigation and communication, and an integrated automatic flight control system. While an enemy plane is still beyond the range of human eye, this radar system will detect it, and provide the intercepting pilot with a continuous flow of information, electronically computed in terms of position, range and rate of closing. Associated with RCA in the project are the Minneapolis-Honeywell Regulator Company and several Canadian firms.

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ground support and test equipment

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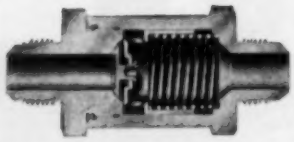
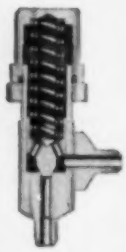


FREE-FLOW CHECK VALVES

No leakage. 3000 psi. Very low pressure drop. Can be furnished to open at ¼ to 35 psi. Brass, stainless steel, or aluminum alloy. ⅛" to 2" pipe or tube. Temp. range -65° to 200°F.

RELIEF VALVES

Quick unloading, smooth operation. Guided shut-off piston with stainless steel or Nylon seat. Pressure range to 4000 psi. Brass, aluminum alloy, or stainless steel. ⅛" to ¾" pipe or tube. Temp. range to 400°F.



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LEVELATOR VALVE

For automatically maintaining height and level condition in any vehicle with air spring suspension. Controls swaying in transit, and off-level position while standing. Applicable to trucks, buses, trailers, carriers, cranes, etc.

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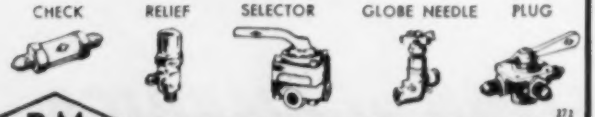
2 pumps, 2 relief valves, and 2 needle shut-off valves, compactly manifolded for elevating mechanisms, hydraulic applications on ground support equipment, etc. Aluminum alloy body, stainless steel trim. -65° to 160°F.

Distributors in principal cities coast to coast

CHECK RELIEF SELECTOR GLOBE NEEDLE PLUG



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It's significant that Non-Linear Systems engineers selected thirteen miniature Bristol Syncroverter* high-speed relays (inset, top) for use in the converter scanning circuits. This versatile, high-speed, polarized relay has earned an enviable reputation for reliability, long life and immunity to shock and vibration in just such critical low-level, dry-circuit applications.

Are dry circuits your problem?

If so, we believe we have the answer. Dry-circuit reliability and long life are outstanding features of the Syncroverter high-speed relay. It's unaffected during severe shock and vibration. It has fast pull-in and drop-out and negligible contact resistance, and it operates reliably over a wide temperature range.

More than 20 models available

You can specify Bristol Syncroverter high-speed relays in an extremely wide variety of operating characteristics and in various case and mounting arrangements. Ask us for complete details. Write: The Bristol Company, 173 Bristol Road, Waterbury 20, Conn. B-3A

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BRISTOL FINE PRECISION INSTRUMENTS FOR OVER 68 YEARS

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m/e news

Electronics Contract Awarded to Sylvania

Receipt of a $2.63 million contract award from the U.S. Army Signal Research & Development Lab., Ft. Monmouth, N.J., for a "continuation of development work in electronics" has been announced by Sylvania Electric Products, Inc.

Sylvania reported that the award is a continuation of a research and development contract originally awarded six years ago, which has been renewed on an annual basis. Work on the contract is being carried out at the company's Electronic Defense Laboratory.

Electronic Circuit Package Facilities Now Available

The "packaging" of electronic circuits, from schematic diagram to the final printed circuit or modular form, has become a highly specialized part of product design. Space restrictions, temperature, shock and vibration requirements are often severe.

The potentialities and limitations of the printed circuit process, and its many modular forms, present their own problems. Proper "packaging" can reduce manufacturing cost and greatly increase reliability.

An engineering service, covering this phase of electronic design, has been inaugurated by Arthur Ansley Mfg. Co., New Hope, Pa. The company has reported that printed circuit manufacturing facilities are available for making prototype boards to test the final design.

STL Missile Symposium Investigates AF Program

Scientific and technical experts in the field of ballistic missiles from the nation's leading universities, research laboratories and industrial firms attended the Third Annual Ballistic Missile Symposium held recently at the Ramo-Wooldridge Space Technology Laboratories, Los Angeles.

During the two-day classified meeting, the missile experts attended special scientific sessions and exchanged information through the presentations of technical papers on major aspects of the Air Force Ballistic Missile Program.

Co-hosts for the event were Maj. Gen. B. A. Schriever, commander of the Ballistic Missile Division, Air Research and Development Command, USAF; and Dr. Ruben Mettler, vice president of STL.

Among the organizations represented were: Massachusetts Institute of Technology, AC Spark Plug, Lockheed

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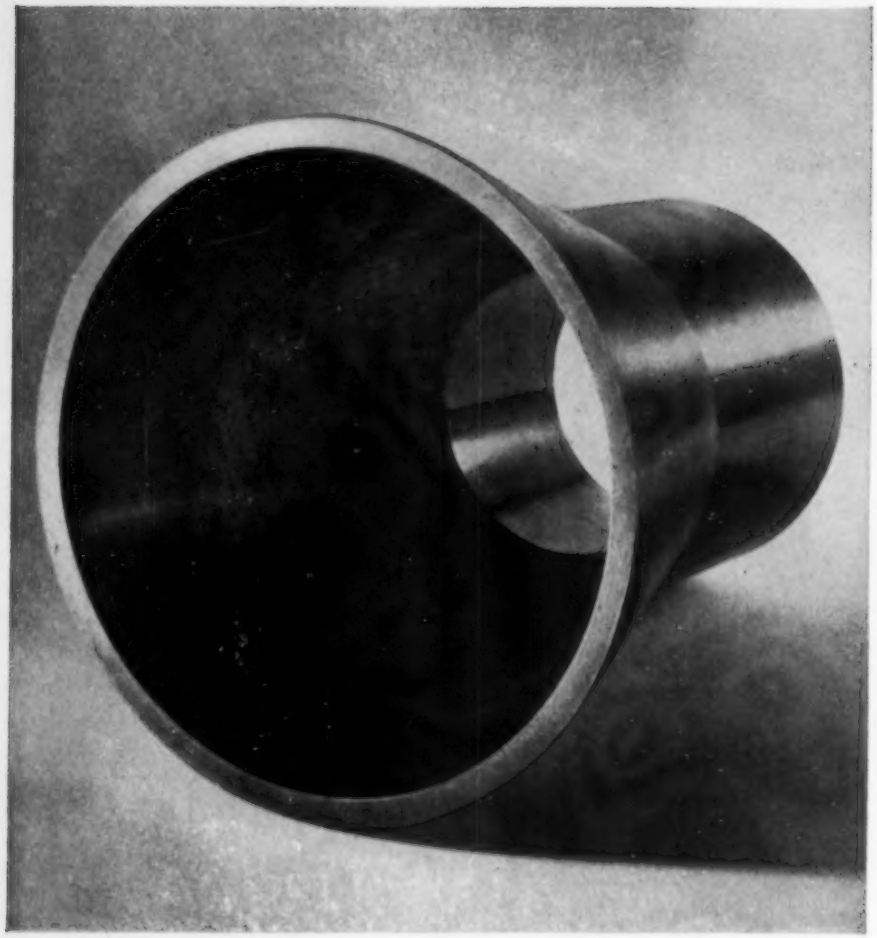
Solution: **R/M PYROTEX REINFORCED PLASTICS**



When missile temperatures rise as high as 10,000°F, and you have to meet structural as well as thermal insulation requirements, your problem is a big one. You have an excellent solution: R/M Pyrotex—a complete line of asbestos-base reinforced plastic materials.

The rocket exhaust throat shown here is an example of what these important new R/M materials can do for you. They provide exceptionally high strength-to-weight ratios, take a smooth finish, and can be mass produced to precision standards. Other missile parts for which R/M Pyrotex has been selected: nose and exhaust cones, blast tubes, grain seats, fins and combustion chamber liners. If heat extremes are part of your problem, it will pay you to get more details on R/M Pyrotex!

For further information, write for technical bulletin

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Aircraft, General Electric, Martin Co., Burroughs Corp., Scientific Advisory Committee, Scientific Advisory Board, Avco Manuf., University of Michigan, Aero-jet General, Convair, Bell Telephone Labs, Douglas Aircraft, Remington Rand, American Machine and Foundry.

Joint sponsors of the symposium were the Ballistic Missile Division, the Ballistic Missile Office, Air Materiel Command, USAF; and STL.

May Transistor Sales Close To 3 Million Units

Factory sales of transistors during the month of May amounted to 2.99 million units, with a dollar value of $7,250 million. This is an increase of 142,964 units and $225,277 over the sales figures for April 1958, and 944,-198 units worth $1,614 million over the figures for May 1957.

The sales report, issued by Electronics Industries Association, also indicates that the cumulative sales of transistors during the first five months of this year increased substantially over the same period in 1957. Sales figures for the period January through May 1958 totaled 14,894 million units valued at $34,582 million, compared with 8,954 million transistors with a value of $25,128 million sold during the same period last year.

The EIA chart below shows factory sales and dollar values for the January-May period of 1958. The unit figures for the corresponding months of 1957 are included for comparison purposes.

	1958 Sales (units)	1958 Sales (dollars)	1957 Sales (units)
January	2,955,247	$6,704,383	1,436,000
February	3,106,708	6,806,562	1,785,000
March	2,976,843	6,795,427	1,904,000
April	2,856,234	7,025,547	1,774,000
May	2,999,198	7,250,824	2,055,000
TOTAL	14,894,230	$34,582,743	8,954,000

Magnavox Forms New Subsidiary

Magnavox Co. of Ft. Wayne, Inc., has announced the formation of a new subsidiary—Magnavox Astro-Physics Laboratories, Inc., which is to be located in Rochester, N.Y. The initial efforts of the company will be under the direction of Col. James W. Anderson, Jr., (USAF-ret), who was connected with Rome Air Development Center until November, 1957. The new subsidiary was formed to meet future defense needs in the field of missile and space technology.

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W. Coast Co. to Develop Missile Electronic Systems

Formation of a new subsidiary company for the development of ground and airborne electronic equipment for missiles and space vehicles has been announced by Pacific Automation Products, Inc., Glendale, California, manufacturers of engineered cable systems for missiles and missile bases.

The new organization—Space Electronics Corp.—is headed by Dr. J. C. Fletcher and Frank W. Lehan, formerly director and assistant director respectively of the Electronics Laboratory of the Ramo-Wooldridge Corp.

Before joining R-W, Dr. Fletcher was head of the System Laboratory of the Guided Missile Division at Hughes Aircraft Co. He is president of the new company.

Lehan was formerly chief of the Electronics Research Section of Jet Propulsion Laboratory.

In addition to developing electronics subsystems for missile and space programs, Dr. Fletcher said the new company would conduct research into electronic techniques generally applicable to space vehicles, but which are not yet ready to be intergrated into a system.

The president of Pacific Automation Products, Inc., Frank G. Jameson, said that SEC will be affiliated with the parent company in some joint enterprises, but in most cases will work independently.

The biographical material released in connection with the formation of the new organization describes Dr. Fletcher and Lehan as having been responsible for development of the guidance and control systems for all missiles in the Air Force Ballistic Missile Program, including the solid propellant *Minuteman*.

Nike Communication System Planned for Alaska

A contract for installation of two inter-battery microwave communication systems between *Nike* missile sites and anti-aircraft operation centers (AAOC) in Alaska has been awarded to Philco Corporation's Government and Industrial Division.

The $1,050 million contract, awarded by the U.S. Army Engineer District Alaska, which performs construction for the Army and Air Force in Alaska, also calls for one year's maintenance of the system from completion date of the project.

The communications system was planned and designed by the Headquarters Signal Office, U.S. Army

How KENNAMETAL* Sealing Rings...

Help to Withstand High Temperatures . . . A jet engine shaft seal of Kentanium,* a titanium carbide, operating without lubrication at 15,000 surface feet per minute at 1000°F and 0.6 pounds pressure per lineal inch of circumference outperformed every other material tried. Kentanium is stress-free, dimensionally stable, maintains great strength and provides exceptional resistance to abrasion. It is providing all of these advantages on many applications . . . at temperatures up to 2000°F and as high as 5000°F for momentary service.

Help Solvent Separators to Resist Abrasion . . . On this job, Kennametal rings of Grade K96 were installed, replacing conventional seals which had at no time given more than two months' service and had sometimes failed in only 30 hours. Kennametal rings were inspected after six months in service, showed no perceptible wear and were returned to service. The customer predicts an ultimate service advantage of 50 to 1.

Help to Power Rockets . . . Here the sealing rings are used to handle red fuming nitric acid. After extensive testing of materials, rings made of Kennametal K501, a platinum-base composition, were chosen. The manufacturer reports: "Kennametal ring sealing results have been far superior to any other material with no indication of seal face wear." This was after the best life of the rings previously used had been exceeded.

For details, write for 24-page Booklet B-111, "Characteristics of Kennametal" . . . and 12-page Booklet B-444 which describes "Kentanium." KENNAMETAL INC., Dept. MR, Latrobe, Pa.

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Alaska, with engineering assistance from the Army Signal Engineering Agency in Washington.

One microwave system will consist of a four-station hook-up of *Nike* sites in the Fort Richardson-Elmendorf Air Force Base area and the AAOC on Fire Island near Anchorage.

The other six-station communication system will connect the *Nike* batteries guarding the Ladd AFB-Eielson AFB area with the AAOC at Murphy Dome near Fairbanks.

This microwave equipment, which operates in the 6,000 to 8,000 megacycle frequency range, will be equipped with full automatic standby transmitter and receiver units, automatic switching devices and suitable alarms. It also is equipped with a duplexing tee for transmitting and receiving on the same antenna.

All antennas in the Alaska *Nike* microwave system will be equipped with heated plastic covers to keep them free of snow and ice. The covers also will protect the antenna feed horn from rain, dust and condensation.

The CLR-9 uses "heat sinks" instead of blowers to cool the klystrons, eliminating extensive blower maintenance and klystron failures caused by faulty blowers.

In the tubeless power supply, vacuum tubes have been replaced with new semi-conductor rectifiers which provide long life potential and cooler operation of the power supply.

Operational *Nike* missile battalions in Alaska are part of air defense under control of the Alaska Command.

IT&T Establishes New Space Lab

International Telephone and Telegraph Corp. has established a new space laboratory at Fort Wayne, Ind. for systems research and development. Main work will be on guidance and control, data processing and instrumentation of space vehicles.

Projects under study include: a radio relay system using a number of "fixed" satellites for world-wide dial telephoning and television transmission; an interplanetary navigation system for manned space ships; space-to-earth communication systems using compressed radio bandwidths.

Donald M. Culler has been named head of the new astronics lab. The staff will be augmented by a consulting group of scientists from midwestern universities, according to Henri Busignies, IT&T Laboratories president.

Pressurization Units for Guidance Systems

Two new pressurization units for use in missile guidance systems have been developed by Eastern Industries, Inc.

Model E/AP 100, Type 202, provides circulation of pressurized and dehydrated air to the wave guide of a radar system within a missile. The second unit, Model PRD 50, Type 100, is designed for use in tracking and guidance of ground-based missile operating controls.

The model for use in missiles is a single-cylinder compressor and motor assembly, a pressure relief valve and a DP-600 Type 100 dehydrator mounted on a common base. Total weight is 4 and ¾ lbs and delivers 150 cu. in. per minute and maintains a system pressure of 25 psi minimum.

The ground-based unit features a built-in stand-by with automatic change-controls. Dehydration is achieved through the use of dual cascade refrigeration systems.

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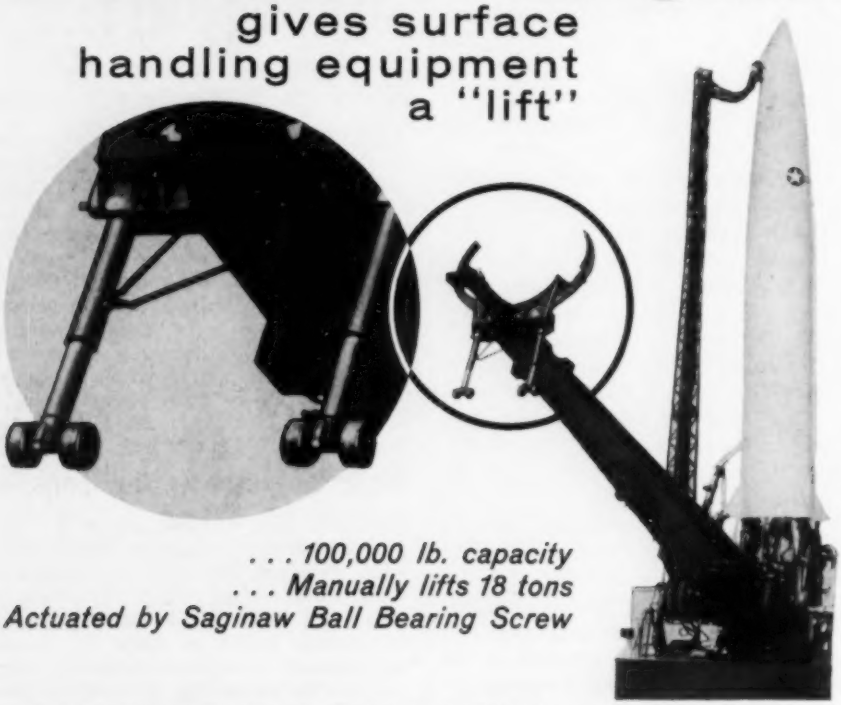
BINKLEY Leveling Jack
gives surface handling equipment a "lift"



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Binkley's extensive experience stems from over 25 years designing and manufacturing truck and trailer body parts and components, including landing gear similar to that shown here. You can benefit from this experience by taking your ground handling equipment problems to Binkley for expert confidential attention.

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book reviews

WAR—1974, by Lt. Col. Robert B. Rigg, USA 304 pp., $5, The Military Service Publishing Co., Harrisburg, Pa.

This is a dramatic, action-packed account of a future global war. The book is fiction, but is by no means fantasy. The story is based on known facts, on weapons now being used by our armed forces, plus machines of warfare on the drawing boards or undergoing tests.

The book is packed with episodes ranging from hidden struggles below the earth in secret missile bases to electronic combat and undersea warfare with strange drone craft. All of this action takes place on future battlegrounds.

NONLINEAR CONTROL SYSTEMS by Robert L. Cosgriff, 328 pp., $9, McGraw-Hill, New York

This book is another in McGraw-Hill's series on Control System Engineering. The book aims to provide the control engineer with those methods of nonlinear systems which are practical in the control field.

The selection of material is such that an extensive background is not required. Only those methods and techniques which are practical from an engineering standpoint have been included, and all mathematics beyond calculus is developed in the book.

Emphasis is placed on nonlinear theory and nonlinear equations. All important points are illustrated by examples, and the book includes a short, concise treatment of linear theory.

The material is arranged to proceed from the simple to the complex, and the author has made use of the concepts and terminology of automatic-control theory rather than those of classical mechanics.

CONFERENCE ON EXTREMELY HIGH TEMPERATURES edited by Heinz Fischer and Lawerence C. Mansur, 275 pp. $9.75, John Wiley & Sons, Inc., New York.

Based on the Conference on Extremely High Temperatures held in 1958, this book is a summary of the underlying basis for commercial or usable thermonuclear reactions. Emphasis is on high temperatures as they relate to the propulsion fields, with lesser emphasis on the physics of the topics covered.

The conference was held under the sponsorship of the Air Force Cambridge Research Center, Electronics Research Directorate.

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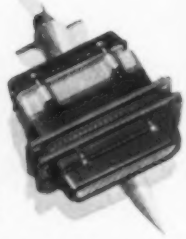

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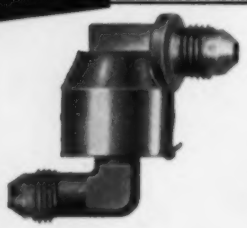

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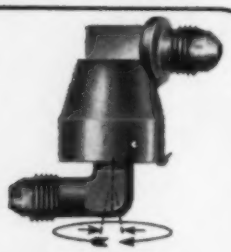

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where and when

AUGUST

ARS, IAS, Regional Technical Meeting, "Space Exploration", San Diego, Calif., Aug. 5-6.

American Institute of Electrical Engineers, Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, Hotel Statler, Los Angeles, Calif., Aug. 6-8.

American Society for Quality Control Annual Conference, Western Region, El Cortez Hotel, San Diego, Calif., Aug. 7-8.

Continuation Course, Modern Development in Heat Transfer, University of Minnesota, Minneapolis, Minn., Aug. 7-15.

AIEE, IRE, NBS, Conference on Electronic Standards and Measurements, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Aug. 13-15.

Industrial Applications of X-Ray Analysis, Seventh Annual Conference, Albany Hotel, Denver, Colo., Aug. 13-15.

Missiles Operations Research Engineering Seminar, Pennsylvania State University, University Park, Pa., Aug. 17-23.

AAS Annual Western Regional Meeting, Stanford University, Dinkelspeil Auditorium, Palo Alto, Calif., Aug. 18-19.

ASME, A.I. Ch.E. Conference, Northwestern University, Evanston, Ill., Aug. 18-21.

Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif., Aug. 19-22.

Ninth Annual Congress, International Astronautical Federation, Amsterdam, Holland, Aug. 25-30.

SEPTEMBER

Summer Program, Problems of High-Powered Radar Design, Massachusetts Institute of Technology, Cambridge, Mass. (Security clearance required.) Sept. 2-12.

1958 Cryogenic Engineering Conference, Massachusetts Institute of Technology, Cambridge, Mass., Sept. 3-5.

First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain, Sept. 8-13.

American Rocket Society, Fall Meeting, Hotel Statler, Detroit, Mich., Sept. 15-18.

13th Annual Instrument Automation Conference, Convention Hall, Philadelphia, Pa., Sept. 15-19.

ASQC, 5th Annual San Francisco Bay Area Conference, Stanford University, Palo Alto, Calif., Sept. 19.

Professional Group on Telemetry and Remote Control, 1958 meeting, Americana Hotel, Bal Harbor, Miami Beach, Fla., Sept. 22-24.

Standards Engineers Society, Seventh Annual Meeting, Franklin Hotel, Philadelphia, Pa., Sept. 22-24.

Air Force Association, Airpower Showcase, Dallas, Texas, Sept. 25-27.

ASME Power Conference, Statler Hotel, Boston, Mass., Sept. 28-Oct. 1.

National Aeronautic Meeting, Society of Automotive Engineers, Inc., Ambassador, Los Angeles, Calif., Sept. 29-Oct. 3.

OCTOBER

Association of the United States Army 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

SAMA Laboratory Apparatus and Optical Sections' Midyear Meeting, Westchester Country Club, Rye, N.Y., Oct. 26-28.

Institute of Radio Engineers East Coast Conference, Aeronautical & Navigational Electronics, Lord Baltimore Hotel, Baltimore, Oct. 27-28.

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